(ACOM LOGO) (JPO LOGO)

OPERATIONAL CONCEPT DOCUMENT

FOR THE

TACTICAL CONTROL SYSTEM

(TCS)

(TCS LOGO)

18 FEBRUARY 1997

TCS CONOPS TABLE OF CONTENTS

ACRONYMS

AADC	Area Air Defense Commander
ACA	Airspace Control Authority
ACO	Air Control Order
ACOM	Atlantic Command
ACP	Airspace Control Plan
ACS	Aerial Common Sensor
ACTD	Advanced Concept Technology Demonstration
ADCOM	Administrative Command
ADOCS	Army Deep Operations Coordination System
AFATDS	Advanced Field Artillery Tactical Data System
AFMSS	Air Force Mission Support System
AO	Area of Operation
A_O	Operational Availability
AOR	Area Of Responsibility
AP	Area Planning
APS	Army Planning System
ASAS	All Source Analysis System
ATHS	Automatic Target Handoff System
ATM	Air Tasking Message
ATO	Air Tasking Order
ATWCS	Advanced Tomahawk Weapon Control System
AVGAS	Aviation Gasoline
AWE	Advanced Warfighting Experiments
BDA	Battle Damage Assessment
BN	Battalion
CARS	Contingency Airborne Reconnaissance System
CCTV	Closed Circuit TV
CI	Consolidated Instructions
C^4I	Command, Control, Communication, Computers and Intelligence
CINC	Commander in Chief
CIO	Central Imagery Office
CJCS	Chairman of the Joint Chiefs of Staff
CJTF	Commander, Joint Task Force
COCOM	Combatant Command
COMSAT	Commercial Satellite
COMSEC	Communications Security
CONOPS	Concept of Operations
CONUS	Continental United States
CUCV	Commercial Utility Cargo Vehicle
CV(N)s	Aircraft Carriers (Nuclear)
DAMA	Demand Access Multiple Assignment
DARO	Defense Airborne Reconnaissance Office
DARS	Daily Aerial Reconnaissance Syndicate
DE	Data Exploitation
DEMPC	Data Exploitation, Mission Planning and Communication
DIA	Defense Intelligence Agency
DISNET	Defense Integrated Secure Network
DOD	Department of Defense
DSN	Defense Switched Network

DUSD/AT	Deputy Under Secretary of Defense Advanced Technology
EEI	Essential Elements of Information
EO	Electro-Optical
ETRAC	Enhanced Tactical Radar Correlator
FAR	Federal Aviation Regulation
GB	Gigabyte
GCCS	Global Command and Control System
GCS	Ground Control Station
GP	General Planning
GPS	Global Positioning System
GSM	Ground Station Module (JSTARS)
HAZCOM	Hazardous Components
HEMTT	Heavy Expanded Mobility Tactical Truck
HF	High Frequency
HMMWV	High Mobility Multi-purpose Wheeled Vehicles
IAS	Intelligence Analysis System
I&W	Indications and Warnings
IFF	Identification, Friend or Foe
IMINT	Imagery Intelligence
INCONUS	In Continental United States
INS	Inertial Navigation System
INSCOM	Intelligence and Security Command (USA)
IPB	Intelligence Preparation of the Battlefield
IPF	Integrated Processing Facility
IPR	In Progress Review / Interim Pulse Repetition
IPR	Imagery Phase Response
IR	Infrared or Instrument Route
ISDB	Integrated System Data Base
ISE	Intelligence Support Element
J2	Intelligence
J3	Operations
JAC	Joint Analysis Center
JCS	Joint Chiefs of Staff
JDISS	Joint Deployable Intelligence Support System
JFACC	Joint Force Air Component Commander
JFC	Joint Force Commander
JICs	Joint Intelligence Centers
JMCIS	Joint Maritime Command Information System
JPEG	Joint Photographic Experts Group
JOG	Joint Operations Graphics
JPO	Joint Project Office
JRC	Joint Reconnaissance Center
JSIPS-N	Joint Service Imagery Processing System Navy
JSTARS	Joint Surveillance Target Acquisition & Reconnaissance System
JTAR/S	Joint Tactical Air Request for Surveillance
JTF	Joint Task Force
JTFC	Joint Task Force Commander
JTTP	Joint Tactics, Techniques, and Procedures

JWICS	Joint Worldwide Intelligence Communications System
KTS	Knots
LHAs	Amphibious Helicopter Assault
LHDs	Amphibious Helicopter Dock
LI	Local Interconnect
LNO	Liaison Officer
LOS	Line of Sight
LRU	Line Replacement Unit
MAE UAV	Medium Altitude Endurance Unmanned Aerial Vehicle
MC	Mission Commander
META	
MHE	Material Handling Equipment
MI	Military Intelligence
MIES	Modernized Imagery Exploitation System
MILSAT	Military Satellite
MOU	Memorandum Of Understanding
MSDS	Material Safety Data Sheets
MSL	Mean Sea Level
N.A.S.	Naval Air Station
NIIRS	National Imagery Interpretation Rating Scale
NIMA	National Imagery & Mapping Agency
NITF	National Image Transmission Format
NM	Nautical Miles
NMJIC	National Military Joint Intelligence Center
NRT	Near Real-Time
OCONUS	Outside the Continental United States
OIC	Officer In Charge
ONC	Overlay Navigational Charts
OPCON	Operational Control
OPLAN	Operation(s) Plan
OPORD	Operations Order
OTH	Over-The-Horizon
PCA	Positive Control Airspace
PEO	Program Executive Officer
PIR	Priority Intelligence Requirements
PM	Project Manager
PMCS	Preventive Maintenance Checks and Servicing
PME	Primary Mission Equipment
PO	Payload Operator
POC	Point of Contact
POL	Petroleum, Oil and Lubricants
PPO	Pilot and Payload Operator
RFI	Request For Information
RSTA	Reconnaissance, Surveillance, and Target Acquisition
SAR	Synthetic Aperture Radar

SATCOM	Satellite Communications
SHF	Super High Frequency
SGDT	SATCOM Ground Data Terminal
SIGINT	Signals Intelligence
SMEs	Subject Matter Experts
SPINS	Special Instructions
SRO	Sensitive Reconnaissance Operations
TACOM	Tactical Command
TACON	Tactical Control
TAMPS	Tactical Aircraft Mission Planning System
TAS	True Air Speed
TBMCS	Theater Battle Management Core System
TCS	Tactical Control System
TDY	Temporary Duty
TEG	Tactical Exploitation Group
TPFDD	Time-Phase Force Deployment Data
TOT	Time on Target
TUAV	Tactical Unmanned Aerial Vehicle (Outrider)
TS II	Trojan Special Purpose Integrated Remote Intelligence Terminal II
TS	Transfer System
UAV	Unmanned Aerial Vehicle
UHF	Ultra High Frequency
UPS	Uninterrupted Power Supply
USACOM	United States Atlantic Command
USCINCLANT	United States Commander in Chief, Atlantic Command
USCINCPAC	United States Commander in Chief, Pacific Command
USIS	United States Imagery Systems
VFR	Visual Flight Rules
VHF	Very High Frequency
VR	Visual Routes

EXECUTIVE SUMMARY

The Tactical Control System (TCS) is an acquisition category (ACAT) III program to provide military warfighters with a scaleable command, control, communications, and data dissemination system for the family of Tactical Unmanned Aerial Vehicles (UAV). Additionally, TCS will receive/disseminate data from High Altitude UAVs. By being UNIX based and scaleable TCS will provide a capability tailored to the user. The user, when authorized and depending on the mission, can select options ranging from passively receiving UAV payload products up to controlling multiple air vehicles (ultimately including launch/recovery) and payloads. The TCS program using a three phased approach will provide this capability initially using the Service's standard computing platform (existing equipment). For visualization purposes, it would run like the personal computer Windows program offering icons to conduct the operations required. An enhancement chassis (hardware) to "translate" the standards/protocols/formats developed during the program to the service computing system may be required. TCS will define interface requirements, data link protocols and message formats. The standards, protocols, and formats established will ultimately allow UAV systems to overcome the current stovepipe concept (see Figure 4-2) where each system has its own ground station that is not interoperable with other air vehicles. On the ground station side TCS will interface to the existing user infrastructure by accommodating user platform interface requirements. The program will provide the UAV family interoperability on off the shelp service computing hardware platforms and UAV data and information integrated with the Services exisiting Command, Control, Communication, Computer, and Intelligence (C^4I) capability.

The advantages of a system that benefited from interoperability and commonality have been recognized since congress directed DoD to consolidate UAV programs in 1988. Initial attempts focused on commonality (hardware) through the use of a downsized short range UAV ground station and the establishment of interoperability standards (software) through the use of Joint Integration Interfaces (JII). With the advent of the Medium Altitude Endurance (MAE) and High Altitude Endurance (HAE) UAV programs downsizing of existing GCS's would not suffice. More attention was required in integrating the air vehicle into an interoperable, scalable system with established standards and protocols to integrate UAVs into the exisiting and planned future battleforce structure and therefore, interoperablity became the prime consideration. Demonstrations with the Short Range UAV (Hunter) showed that the system could provide imagery to and be controlled from existing service computer platforms. These efforts logically progressed into the TCS concept outlined above. The TCS program will implement the standards and protocols to provide interoperability for exisiting and future air vehicles, which will permit them to operate with existing hardware, software and ground stations.

Phase I of the TCS program will provide program definition and risk reduction through the use of three fieldable prototypes (1 sea-based & 2 land-based) over a 24 month demonstration period. During this phase Predator and Outrider air vehicles and payloads will be integrated with TCS common core functions. Demonstrations with all services will include air vehicle and payload control of Predator and Outrider. The TCS prototypes will interface with user selected C^4I based systems such as ASAS, IAS, JMCIS, etc. Any Advanced Warfighting Experiments (AWE) lessons learned will be inserted into the TCS development process and acquisition documentation developed during this phase.

Phase II will focus on engineering and manufacturing and includes a contract award for the TCS systems integrator. The full and open competition will result in a cost plus incentive fee contract for 6 LRIP systems. System documentation and software developed under Phase I will be provided as GFE/GFI and a developmental/operational test conducted. The contractor will integrate and install TCS sea and land-based systems to include both scaleable modules integrated on existing platform hardware as well as full-up systems. Any Outriders and Predators modified during Phase I or II will be retrofitted to match the LRIP configuration. Modification of future air vehicles and payloads will be through a P^3I program. The government will maintain configuration control and a single systems integration facility for the family of UAVs.

Phase III encompasses production, fielding/deployment and operational support. At this point TCS will be the command, control, and data dissemination system for Predator, Outrider and all future Tactical air vehicles and payloads. A firm fixed price contract for approximately 30 systems a year will be awarded. Additionally, retrofit of fielded Predator and Outrider systems and validation of remaining C^4I interfaces will be accomplished.

Program direction for the Tactical UAV (TUAV) requires the development of a common ground reception, processing and control system to ensure full interoperability with other UAVs and collection systems. The proposed TCS was briefed to, and endorsed by, the Vice Chairman, Joint Chiefs of Staff, the Joint Requirements Oversight Council (JROC), and the Under Secretary of Defense (Acquisition). A JROC Memorandum further states that to fully exploit Predator’s and Outrider’s capability at all levels, it is imperative that these systems become fully compatible and interoperable with the TCS. In addition, the Navy and NATO Project Group 35 have indicated the need for TCS to controll Vertical Takeoff and Landing (VTOL) UAVs such as the Tiltrotor UAV System (TRUS) and SEAMOS.

The purpose of this concept of operations (CONOPS) is to provide a "how to" TCS document on the deployment, operation and interfaces in exercise, test and real world situations. It provides a descriptive overview of the capabilities and limitations to assist the tactical commander in deciding when, where, and how to deploy the TCS. User involvement is required early in the program to ensure the system satisfies their need and operators are knowledgeable and provide input on use of the system. The document is a "living" document being updated as exercises, demonstrations and tests are completed. As such many sections listed in the index will not be available initially, but will be provided in subsequent reviews/approval of the document. The goal is to have the CONOPS screened and coordinated by the Services semi-annually. The document will be updated through the TCS CONOPS Integrated Product Team (IPT) chaired by USACOM and supported by PM-TCS. Therefore, the TCS CONOPS is a living document that will reflect changes in doctrine, hardware and software. The CONOPS will be used to develop/tailor tests, exercises and demonstrations of the TCS.

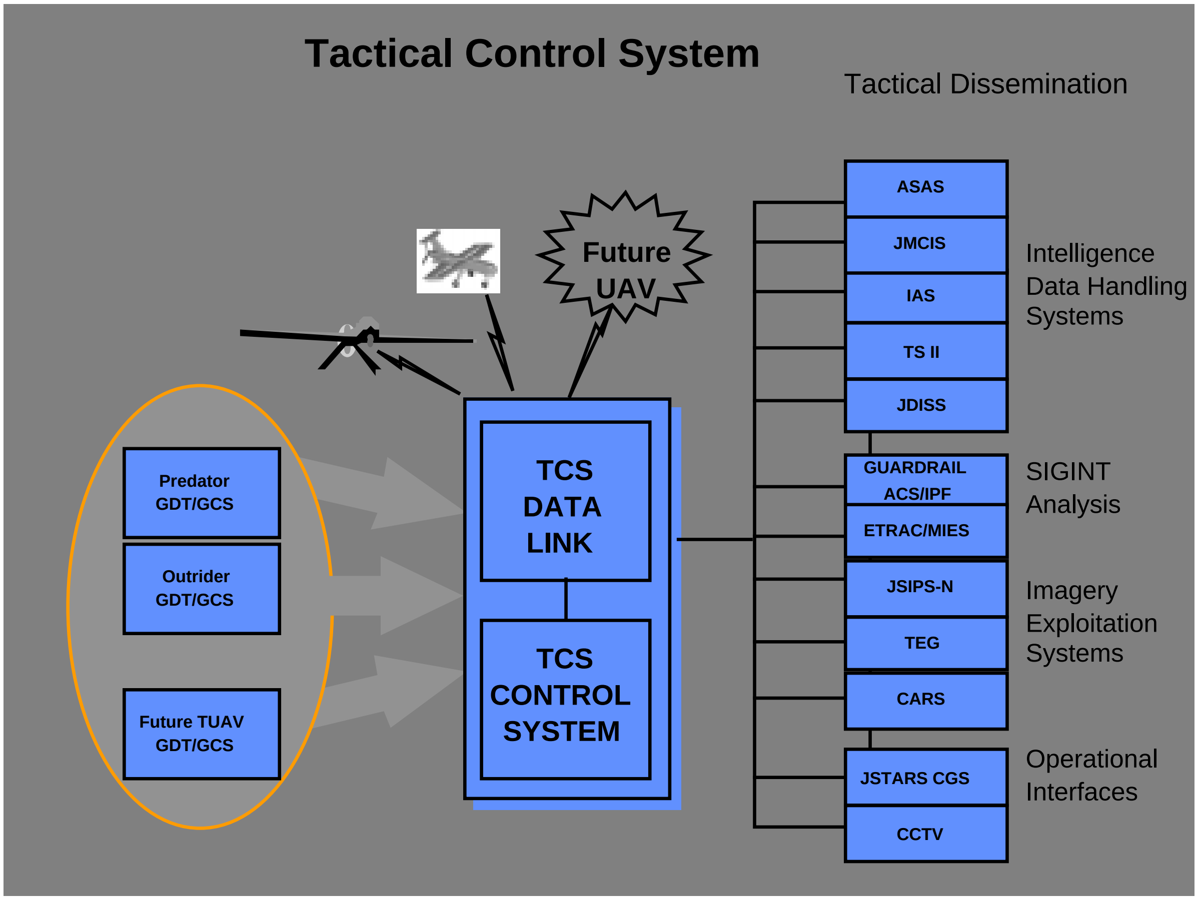

Figure 1 TCS Concept

Figure 1 depicts the TCS concept. Initially, the existing Predator/Outrider ground data terminals and ground control stations will launch, recover and maintain final control authority of the air vehicle. At the conclusion of Phase III these functions may be accomplished by the TCS. Through the LOS, BLOS, or SATCOM data links the AVs provide the payload product to the ground system hosting the TCS. The TCS then interfaces with the appropriate C^4I system for dissemination/exploitation of the product. Service specific operation and manning of the TCS are provided in the Operations Section (4.0) of the CONOPS.

Section One
Introduction

1.1 Purpose

This Concept of Operations (CONOPS) describes the operational employment of the Tactical Control System (TCS) and provides comprehensive details on how to deploy, operate and interface TCS in exercises, tests, and the real world. TCS is designed to enhance joint and service warfighting by providing a command, control and dissemination system for conducting coordinated and unified Unmanned Aerial Vehicle (UAV) operations. The TCS Operational Requirements Document (JORD) specifically states the interoperability requirements which are depicted in Figure 1-1.

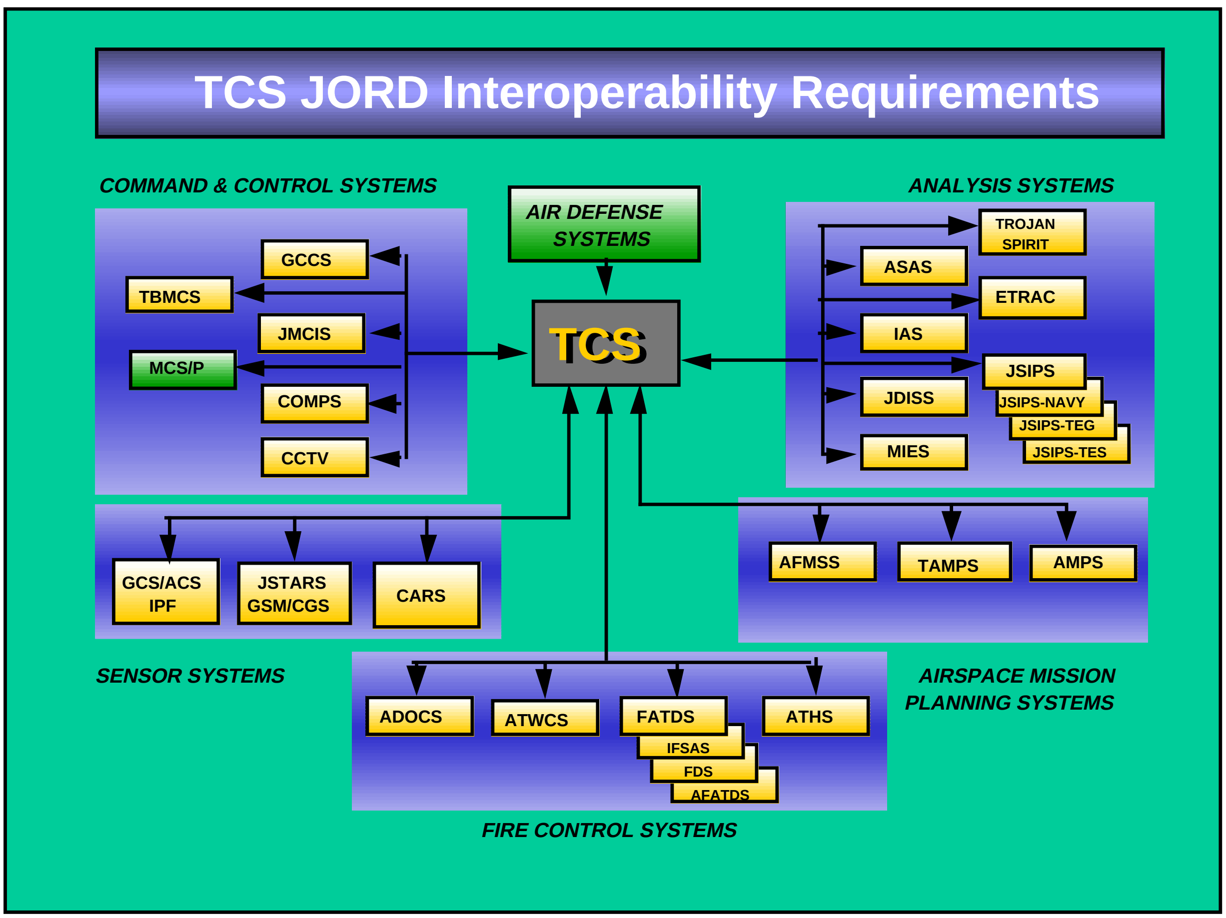

Figure 1-1 JORD Interoperability Requirements

The Tactical Control System (TCS) is an acquisition category (ACAT) III program to provide military warfighters with a scaleable command, control, communications, and data dissemination system for the family of Tactical Unmanned Aerial Vehicles (UAV). Additionally, TCS will receive/disseminate data from High Altitude UAVs. By being UNIX based and scaleable TCS will provide a capability tailored to the user. The user, when authorized and depending on the mission, can select options ranging from passively receiving UAV payload products up to simultaneously controlling multiple/different air vehicles (ultimately including launch/recovery) and payloads.

This Operational Concept provides a "how to" TCS document on the deployment, operation and interfaces in exercise, test and real world situations. It provides a descriptive overview of the capabilities and limitations to assist the tactical commander in deciding when, where, and how to deploy the TCS. User involvement is required early in the program to ensure the system satisfies their need and operators are knowledgeable and provide input on use of the system. The document is being updated as exercises, demonstrations and tests are completed. As such many sections listed in the index will not be available initially, but will be provided in subsequent reviews/approval of the document. The goal is to have the CONOPS screened and coordinated by the Services semi-annually. The document will be updated through the TCS CONOPS Integrated Product Team (IPT) chaired by USACOM and supported by PM-TCS. Therefore, the TCS CONOPS is a living document that will reflect changes in doctrine, hardware and software. It will be used to develop/tailor tests, exercises and demonstrations of the TCS.

1.2 Background

The advantages of a system that benefited from interoperability and commonality have been recognized since congress directed DoD to consolidate UAV programs in 1988. Initial attempts focused on commonality (hardware) through the use of a downsized short range UAV ground station and the establishment of interoperability standards (software) through the use of Joint Integration Interfaces (JII). With the advent of the Medium Altitude Endurance (MAE) and High Altitude Endurance (HAE) UAV programs downsizing of existing GCS’s would not suffice. More attention was required in integrating the air vehicle into an interoperable, scalable system with established standards and protocols to integrate UAVs into the exisiting and planned future battleforce structure and therefore, interoperablity became the prime consideration. Demonstrations with the Short Range UAV (Hunter) showed that the system could provide imagery to and be controlled from existing service computer platforms. These efforts logically progressed into the TCS concept. The TCS program will implement the standards and protocols to provide interoperability for exisiting and future air vehicles, which will permit them to operate with existing hardware, software and ground stations.

1.3 General

The TCS program will use a three phased approach, initially using the Service's standard computing platform (existing equipment). For visualization purposes, it would run like the personal computer Windows program offering icons to conduct the operations required. An enhancement chassis (hardware) to "translate" the standards/protocols/formats developed during the program to the service computing system may be required. TCS will define interface requirements, data link protocols, and message formats. The standards, protocols, and formats established will ultimately allow UAV systems to overcome the current stovepipe concept where each system has its own ground station that is not interoperable with other air vehicles. On the ground station side TCS will interface to the existing user infrastructure by accommodating user platform interface requirements. The program will provide the UAV family interoperability on off the shelf service computing hardware platforms and UAV data and information integrated with the Services exisiting Command, Control, Communication, Computer and Intelligence (C^4I) capability.

Phase I of the TCS program will provide program definition and risk reduction through the use of three fieldable prototypes (1 sea-based & 2 land-based) over a 24 month demonstration period. During this phase Predator and Outrider air vehicles and payloads will be integrated with TCS common core functions. Demonstrations with all services will include air vehicle and payload control of Predator and Outrider. The TCS prototypes will interface with user selected C^4I based systems such as ASAS, IAS, JMCIS, etc. Any Advanced Warfighting Experiments (AWE) lessons learned will be inserted into the TCS development process and acquisition documentation developed during this phase.

Phase II will focus on engineering and manufacturing and includes a contract award for the TCS systems integrator. The full and open competition will result in a cost plus incentive fee contract for 6 LRIP systems. System documentation and software developed under Phase I will be provided as GFE/GFI and a developmental/operational test conducted. The contractor will integrate and install TCS sea and land-based systems to include both scaleable modules integrated on existing platform hardware as well as full-up systems. Any Outriders and Predators modified during Phase I or II will be retrofitted to match the LRIP configuration. Modification of future air vehicles and payloads will be through a P^3I program. The government will maintain configuration control and a single systems integration facility for the family of UAVs.

Phase III encompasses production, fielding/deployment and operational support. At this point TCS will be the command, control, and data dissemination system for Predator, Outrider and all future Tactical unmanned air vehicles and payloads. A firm fixed price contract for approximately 30 systems a year will be awarded. Additionally, retrofit of fielded Predator and Outrider systems and validation of remaining C^4I interfaces will be accomplished. Preliminary estimates indicate a need for the following number of systems by service: 62 Army; 17 USMC; 103 Navy; 12 Air Force; Training 14 (Total 208)

1.4 Threat

The TCS through its scaleable functionality will be subject to the same threats experienced by both front line and rear echelon systems. Because versions of TCS will be man portable they will be subject to environmental conditions at the front as well as the possibility of physical attack/capture by enemy troops. Environmental conditions will be ameliorated by TCSs carried in ships, vehicles, or shelters, however they will still be subject to attack/capture depending on location relative to the enemy position and or weapons capabilities.

Information Warfare threats to TCSs include those in the electromagnetic spectrum. Due to the data links involved active and passive enemy detection capabilities can be employed. The payload product of the TCS can be degraded or eliminated by enemy actions against the air vehicle. While air defense networks vary around the world, a fairly modern, robust, and integrated active radar and passive detection network, could provide adequate warning of approaching UAVs to a target country’s command authority. Through use of numerous types of camouflage, concealment, and deception (CC&D) devices, including multi-spectral netting and radar corner deflectors the effectiveness of the TCS controlled air vehicle can be reduced. Likewise telemetry/communication control links are also susceptible to intercept or jamming. Depending on the theater of operation and hostile electronic combat systems present, the threat to TCS operations could range from negligible to an active jamming effort made against the ground station and air vehicle.

1.5 Organization/Responsibilities

This document provides a descriptive overview of the capabilities and limitations of the TCS to assist the warfighter in deciding when, where, and how to deploy the system. The document has been jointly developed by an integrated product team (IPT) led by USACOM with membership from SOCOM, the individual Services, Joint Staff, the TCS program office and the Training and Doctrine

Commands (TRADOCs) from each of the services. The goal is to get "user" involvement early in the program to ensure the system satisfies the operational need and the operators are knowledgeable in the system's capabilities and limitations. Additionally, this document shows how the TCS could be used and integrated into other current systems, as well as the potential tactical benefits resident in its basic capabilities. The document contains detailed descriptions of how to deploy, operate and interface the system in exercise, test or real world scenarios.

The IPT was started to develop the Concept of Operations (CONOPS). The goal was to have a draft CONOPS completed in time to use during TCS testing and demonstrations. Lessons learned from tests and demonstrations will be included in semi-annual CONOPS updates which are to be screened by the Services and Unified and Specified Commanders. The CONOPS will be signed out by ACOM.

The Concept of Operations is presented from a Joint and Service perspective. Each section provides a general joint description followed by individual service considerations. The basic CONOPS is unclassified however, there are applications which are at a higher classification level, that are not addressed in this document because of the sensitivity of the information. Although the document will not usurp Service prerogatives, any CONOPS developed by the individual Services, which depart from the Joint CONOPS provided herein, should be reviewed by the CONOPS IPT to ensure continuity of operations are not degraded.

The Defense Airborne Reconnaissance Office (DARO) is the Secretary of Defense level resource sponsor and oversight monitor for the TCS program.

The TCS Program Manager (PM), Office code: PM-TCS, resides in the Navy Program Executive Office (PEO) for Cruise Missiles and Unmanned Aerial Vehicles (CU). The PM is responsible for the day-to-day direction of the TCS program. Matrix support is provided through the NAVAIR Systems Command, NAWAD, the Naval Surface Warfare Center (NSWC) Dahlgren Division (DD), the Systems Integration Laboratory (SIL), Army Missile Command (MICOM) and other field activities and support offices.

Section Two
Referenced Documents

2.0 Referenced Documents

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22. Joint Pub 3-56.24, Joint Interface Operational Procedures (01 October 1993).

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24. JROCM 135-95, Tactical Unmanned Aerial Vehicle (31 October 1995)

25. JROCM 010-96, Predator Unmanned Aerial Vehicle (12 February 1996)

26. JROCM 159-96, Unmanned Aerial Vehicle Tactical Control Station Key Performance Parameters (KPPs), (23 October 1996)

27. Multiservice Procedures for Integrated Combat Airspace Command & Control ($ICAC^2$), FM 100- 103/FMFRP 5-61/NDC TAC NOTE 3-52.1/ACCP 50-38/USAFEP 50-38/PACAFP 50-38, (October 1994).

28. National Air Intelligence Center Report, NAIC-1571-731-95, Electronic Combat Threat Environment Description, (April 1995)

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30. Office of Naval Intelligence-Threat Assessment #028-93, Medium Range UAV (UAV-MR), (September 1993)

31. Operational Requirements Document (ORD) for UAV TCS, (January 1997)

32. USACOM Joint Targeting CONOPS (Draft Document, 01 November 1993).

33. USACOM HAE UAV CONOPS, (Version 3.0 April 1996)

34. USACOM MAE UAV CONOPS, (Coordination Draft, September 1995).

35. USCINCLANT Joint Task Force Policy (Coordinating Draft, 18 December 1992).

Section Three
Mission/Description

3.1 Mission Need/ORD Requirements

The mission of the TCS is to provide the warfighters with an interoperable and scaleable command, control, and communications system for the family (Outrider and Predator) of tactical UAVs that interfaces with C^4I systems (Fig 1). TCS will also receive High Altitude UAV data/products for interface with C^4I processing systems. The Chairman of the Joint Requirements Oversight Council (JROC) signed the Mission Need Statement (MNS) for a Close Range Reconnaissance, Surveillance, and Target Acquisition (RSTA) Capability and a MNS for a Long Endurance RSTA capability on 5 January 1990. These MNSs establish the need to interface UAVs with selected standard Department of Defense Command, Control, and Intelligence Systems, Architectures and protocols, both current and planned. The Outrider and Predator systems were initially procured under the Advanced Concept Technology Demonstration (ACTD) acquisition program approach and are not interoperable. The current software and UAV data links do not have compatibility and are not interoperable. The ground control stations do not have neither the required capabilities nor the architectural growth to satisfy all of the operational requirements of the joint Services. Therefore, each time a software or hardware configuration is developed to be compatible with new or improved warfighting systems, a new software contract must be negotiated for each type of UAV control station. Currently, there are no non-materiel alternative solutions that will establish a standard software architecture for UAVs. Subsequent JROC memorandums state the need for the development of a common ground reception, processing and control system to ensure full interoperability with other UAVs and collection systems and specifically, to fully exploit Predator’s capability at all levels, it is imperative the system become fully compatible and interoperable with the UAV Tactical Control System. Therefore, the TCS mission is to enhance Tactical UAVs operational flexibility, and through C4I interfaces increase dissemination of Tactical and HAE UAV payload products.

3.2 Description

The TCS is a software intensive program to provide the warfighter with a scaleable and modular capability to operate UAVs on existing computing systems and interface for dissemination with current and future C^4I processing systems. Scaleable refers to the ability to provide five levels of interaction that range from receipt and transmission of secondary imagery and/or data to full function and control of the UAV from takeoff to landing. Modularity allows use of common hardware and the ability to increase or decrease capability by adding or removing cards, chips, etc., from the system being used. There will be some TCS software related and extra ground support hardware (antenna, cables, etc.) Thus TCS will have the capability to be configured and down-scaled to meet the user's deployability or operator limitations. The program will progress from threshold (initial) to objective (final) capabilities in the three phases discussed in Section 1.3.

The TCS software will run on a common operating system (UNIX based) with an open architecture and will provide the UAV operator the necessary tools for computer related communications, mission tasking, route flight planning, mission execution, and data processing. The software will provide high resolution, computer generated, video graphics that enables a UAV operator that is trained on one UAV system to control different types of UAVs or UAV payloads with minimal additional training. Likewise, TCS video graphics will provide an interface for seamless C^4I. The TCS core software will be Global Command and Control System (GCCS) compliant, non-proprietary, and the architectural standard for future UAVs.

TCS software will run on current services' hardware such as TAC-X (Navy), CHS-II/SPARC 20 (Army/Marines), and SGI/DEC (Air Force). For the USA and USMC, the TCS will be an integral part of the Outrider two HMMWV-based ground control stations (GCS) (See Figure 3-1). The Army will obtain TCSs in addition to those required for Outrider to receive/control Predator UAV information. For the Navy, the TCS will initially support the Outrider and receive Predator payload data aboard L-Class Ships. The TCS will be the control system for future ship-based UAVs and UAV operations. Since ships already provide the necessary infrastructure to support a computer based system (electrical power, environmental control, radio networks, etc.), the TCS is virtually the GCS for the Navy. The Air Force TCS will be an upgrade of the existing GCSs for the MAE UAV. The TCS hardware will allow for long range communications from one TCS to another, temporary data storage expansion, access to other computers to share in processing capability, and multiple external peripherals. TCS software/hardware will accommodate analog (threshold), and digital (objective) datalinks. Proposed land and ship TCS configurations are shown in Figures 3-2 and 3-3 and will be modified based on user inputs.

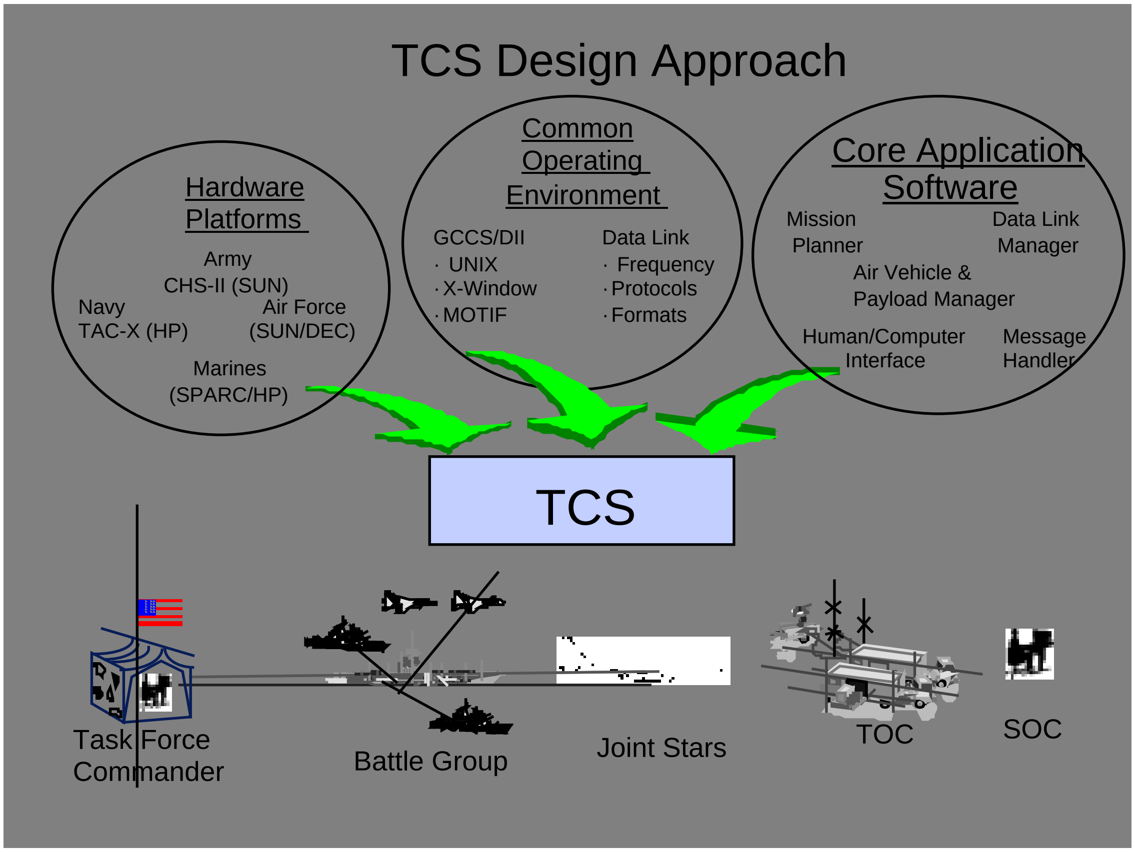

Figure 3-1 TCS Design Approach

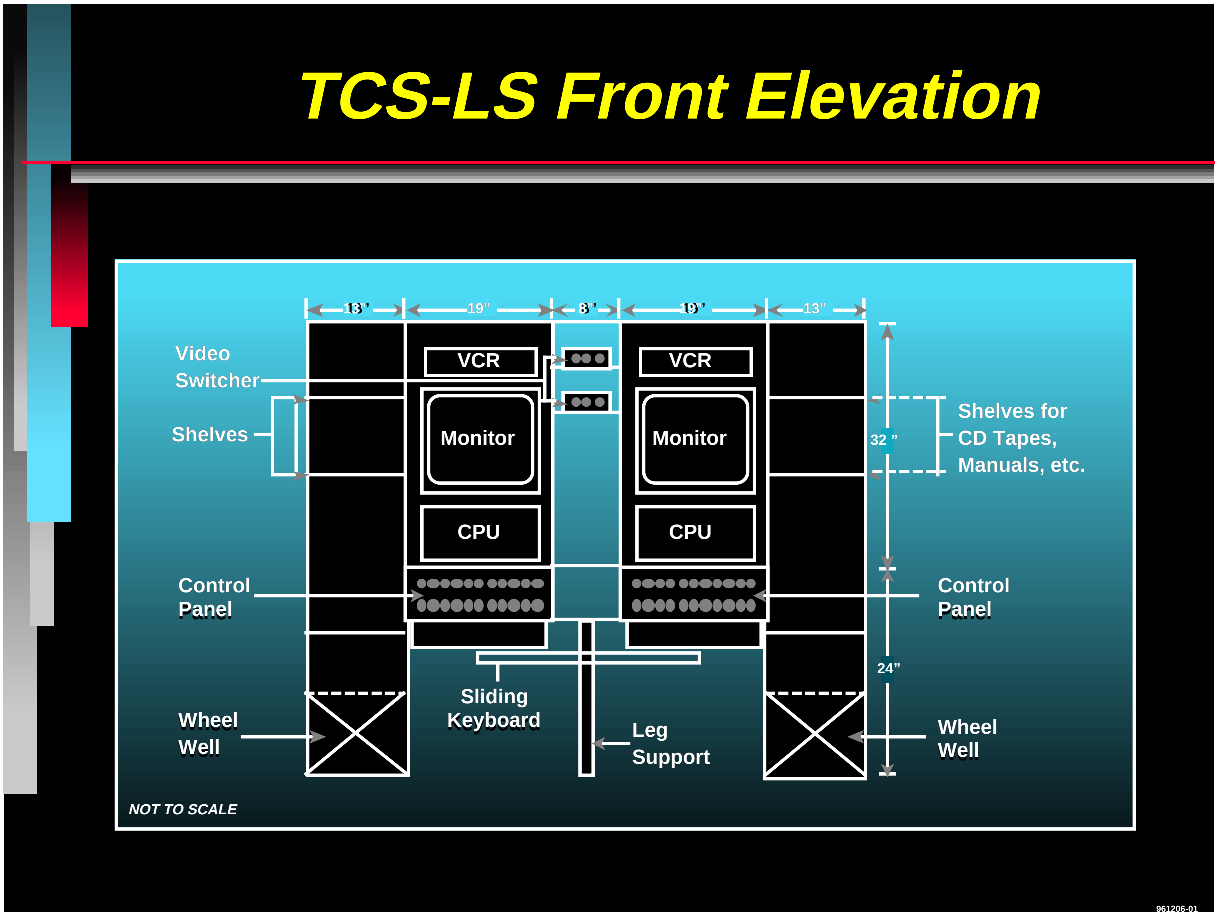

Figure 3-2 TCS Land Configuration

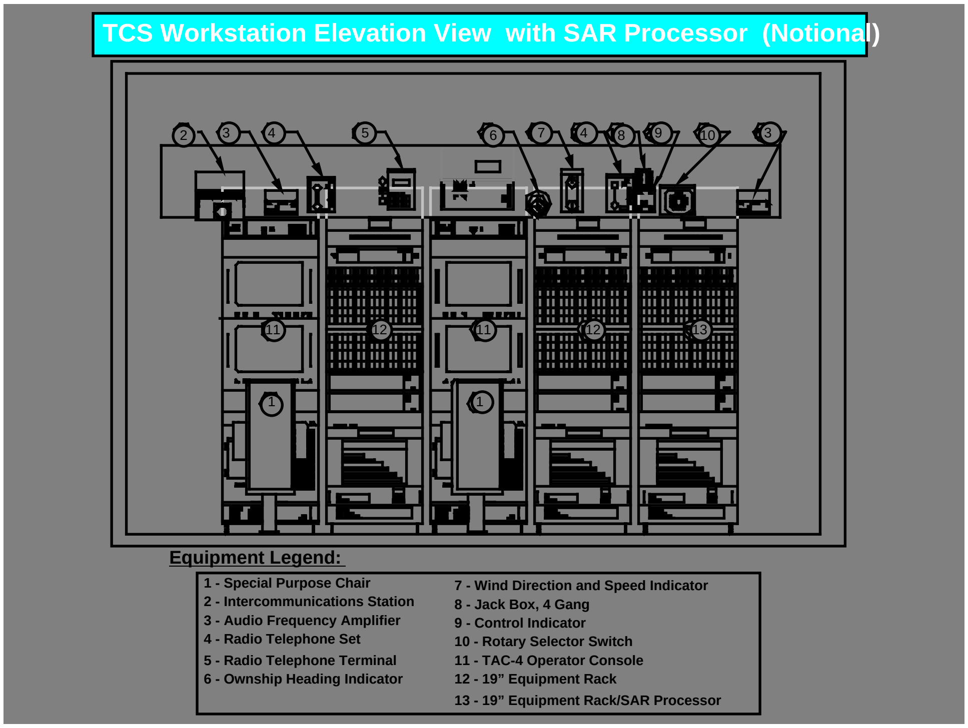

Figure 3-3 TCS Ship Configuration

3.3 Tasks (Threshold)

The TCS will be capable of accomplishing the following threshold tasks by the completion of Phase II.

3.3.1 General System

Be interoperable with different types of UAVs and UAV payloads across 5 levels of UAV interaction to the extent that it is transparent who is operating the air vehicle. The levels of interaction are:

Level 1--Receipt and transmission of secondary imagery and/or data

Level 2--Direct receipt of imagery and/or data

Level 3--Control of the UAV payload in addition to direct receipt of imagery/data

Level 4--Control of the UAV, less launch and recovery, plus all the functions of level 3

Level 5--Full function and control of the UAV from takeoff to landing

Level/Category of Interaction

LEVEL/CATEGORY	REQUIRED FUNCTIONS

SENSOR DATA RECEIPT/TRANSMISSION
1. INDIRECT (via MCE or TCS)
2. DIRECT (UAV to USER)
	· OPERATIONAL COORDINATION
	· RECEIVE AND PROCESS SENSOR DATA
	  · ANALOG (RS-170)
	  · DIGITAL (NITFS, OTHER)
	· DISPLAY SENSOR DATA
	  · OVERLAY ON GEO (MAP) DISPLAY
	  · ANNOTATE (VALUE ADDED)
	· TRANSMIT SELECTED DATA VIA COMM SYSTEMS (SECONDARY DISSEMINATION)

3. SENSOR CONTROL AND DATA RECEIPT/USE	· LEVEL 1 & 2 FUNCTIONS · DIRECT CONTROL OF SENSOR PAYLOAD · VIA LOS LINK OR SATELLITE LINK

4. SENSOR AND AIR VEHICLE CONTROL AND DATA RECEIPT/USE	· LEVEL 3 FUNCTIONS
	· MISSION REPLANNING
	  · AIR VEHICLE ROUTE PLANNING (WAYPOINTS, PRE-DEFINED
	  · PATTERNS)
	· AIR VEHICLE FLIGHT CONTROL

5. FULL UAV CONTROL-LAUNCH TO RECOVERY	· LEVEL 4 FUNCTIONS · MISSION PLANNING · MISSION MONITORING · LAUNCH, · RECOVERY AND LANDING

Figure 3-4 Levels of Interoperability

Enable Outrider and Predator operators to conduct the same functions accomplished in each system’s ground control station (GCS)i.e. communicate, receive mission tasking, conduct mission planning, execute the mission, collect payload products, process payload data, and interface with C^4I systems for dissemination. These functions can be performed using current Predator and Outrider menu screens.

Require no more than two personnel to operate the system at any moment. Allow two personnel to maintain the TCS system software, computer hardware, communications networks, and associated electrical generation and supply for the system. Data exploiters, communicators, and supervisory personnel will depend on Service concepts of operations.

Provide an open software architecture that can support future UAVs by establishing standards, interfaces and protocols for air vehicle operation.

Develop/use software based on the Defense Information Infrastructure/Common Operating Environment per Assistant Secretary of Defense for Command, Control, Communications, and Intelligence (ASD C^3I) Joint Technical Architecture (JTA).

Use ergonomically designed operator controls and displays that will allow air vehicle and payload operators to perform real time mission control, mission monitoring, and mission updates/modifications while wearing cold weather clothing or operating in a Mission Oriented Protective Posture (MOPP).

Use monitors(s) that provide easy reading of displays.

To improve situational awareness provide the payload footprint on the moving map display with an option to show payload imagery and footprint on the same screen.

Be menu driven and have displays using X-windows and a motif look-and-feel.

Provide peripheral ports to drive external devices such as light tables, repeater video terminals capable of seeing raw and NITF 2.0 imagery, imagery enhancement/exploitation stations, etc.

Be capable of supporting additional software modules for future payloads, payload capabilities (e.g., autosearch and automatic target tracking), and future Tactical UAVs.

Allow operators to have simultaneous flight and payload control of at least two air vehicles, beyond line of sight, using one TCS. In the case of Predator this includes the on station relief capability.

Provide a 50% spare storage capacity over delivered storage used. Provide temporary data storage of 24-72 hours. Interfacing systems will provide the long term archiving of data. Be capable of a 50% throughput increase.

Comply with the ASD (C^3I) JTA. This includes, but is not limited to, the language, computer, database, architecture and interoperability.

Use standard military worldwide 110/220 volt 50/60 hertz generators and commercial power sources. Use standard electrical power sources available within the Department of Defense (DoD) family of ground mobile, airborne, and shipboard electrical power sources. TCS will restore power in sufficient time to avoid loss of critical mission data or loss of AV control during power outages. An uninterrupted power supply for critical phases of mission execution will be available.

Operate in world wide climatic conditions, i.e., same climatic conditions in which the TCS shelter/platform is designed to operate.

Meet the mission capability criteria established by the Predator and Outrider ORDs. Provide full, independent computer redundancy for these systems.

Meet the security requirements of the operational and physical systems with which it is interoperable.

3.3.2 Mission Planning

Import National Imagery and Mapping Agency (NIMA) Digital Terrain Elevation Data (DTED), Digital Feature Analysis Data (DFAD), Arc Digitized Raster Graphic (ADRG) and scanned hard copy maps, via compact disk. Importing of map information will be via operator procedure.

Provide basic flight planning tools such as; weight and balance take off calculations, fuel calculations, terrain avoidance warning and minimum reception altitude calculations for line of sight flights, payload planning calculations, etc.

Provide point-and-click route and sensor planning. This type capability makes it transparent as to what type air vehicle/payload is being used and is an important step to developing standard screens, menus, etc for operation of future air vehicles/payloads from the TCS.

Program air vehicles and payloads (if capable) with mission planning data prior to launch.

3.3.3 Survivability Planning

Provide automatic system safeguards (minimum safe enroute altitudes etc.) to prevent unsafe flight attitudes and possible loss of air vehicles/payloads.

Provide manual override of any automated/preprogrammed inputs for the air vehicle and payload.

Store mission plans and export them to other TCSs

Enable changing of the mission plan while the air vehicle is airborne (dynamic replanning).

Enable changing of the sensor collection plan while the air vehicle is airborne and conducting the collection mission (dynamic retasking).

3.3.4 Launch and Recovery

Be ergonomically designed and provide sufficient cues to allow the pilot to safely take off, land and navigate under Instrument Flight Rules.

3.3.5 Mission Execution / Operations

Display the location and onboard systems status of the air vehicle.

Display the search footprint of the payload on the moving map screen.

Accomplish dynamic mission replanning and sensor retasking during the operational mission.

Receive, process, format, store, retrieve and perform limited exploitation of flight/payload data. This includes selective automatic annotation of available air vehicle / payload telemetry (META) data as well as limited operator annotation. While the TCS is not an exploitation system the formats it provides to C^4I systems will expedite their exploitation.

Receive and control payloads on a UAV that is being controlled from another TCS.

Pass control of an AV from one TCS to another.

Provide an override or function lock out capability so the launch and recovery GCS can take control and recover the air vehicle if required.

Provide the operator a caution/warning when the UAV system has identified a malfunction.

Enable antenna switching when the UAV is masked by obstructions

3.3.6 Imagery Intelligence Processing

Provide limited exploitation capabilities, to include voice and textual reporting for spot/mission objectives.

Accomplish video/SAR frame grabbing, image annotation, image archiving (temporary data storage), video/SAR recording/ playback, and data dissemination.

Comply with Common Imagery Ground/Surface Station (CIGSS), United States Imagery Standards (USIS), and the Global Command and Control System (GCCS) standards.

Display Near Real Time (NRT) imagery with selected annotations such as date/time group, target location when in the center field of view, north seeking arrow, AV position/altitude and heading.

Built-in word processing and text capability including the ability to overlay textual information on imagery.

Ports for outputting data and imagery to a hardcopy printer and recording media.

A means of inputting data from external data storage systems.

Distribute NRT video to selected users (including commercially available television monitors and VCRs) via external ports.

Accomplish image enhancement (i.e. edge sharpening, contrast adjustments, black/white reversal, etc).

Ability to select/deselect cross hairs (or other similar ICON) to identify center of target.

Ability to display target symbols.

Interoperate with a server to receive, extract and push intelligence data.

3.3.7 Communications Subsystems

Provide simultaneous uplink and downlink data links.

Provide interfaces with the existing respective (Outrider, Predator, etc.) UAV program-provided data links for command and control as well as UAV data.

Ensure data links support simultaneous LOS and beyond LOS operations.

Capable of entering DII-COE compliant C^4I systems, to include GCCS, that comply with the Technical Architecture

Framework for Information Management and the Joint Technical Architecture (JTA). Be interoperable, as a minimum, with the following C^4I systems per ASD (C^3I) JTA standards:

Automatic Target Hand-off Systems (ATHS)--data burst connectivity

Advanced Field Artillery Tactical Data Systems (AFATDS)--data burst connectivity

All Source Analysis System (ASAS)--wire connectivity

Army Deep Operations Coordination System (ADOCS)

Intelligence Analysis System (IAS)--wire connectivity

Joint Standoff Target Attack Radar System (JSTARS) Ground Station Module/Common Ground Station (GSM/CGS)--wire connectivity

Joint Maritime Command Information System (JMCIS)

Closed Circuit Television (CCTV)

Advanced Tomahawk Weapons Control Station (ATWCS)

Joint Deployable Intelligence Support System (JDISS)

TROJAN Special Purpose Integrated Remote Intelligence Terminal (SPIRIT) II

Joint Service Imagery Processing System (JSIPS)

JSIPS-Navy (JSIPS-N)

Tactical Exploitation Group (TEG)

Theater Battle Management Core System (TBMCS)

Service Mission Planners (TAMPS, AFMSS, APS etc.)

Guardrail Common Sensor/Aerial Common Sensor (ACS) Integrated Processing Facility (IPF)

Modernized Imagery Exploitation System (MIES)

Enhanced Tactical Radar Correlator (ETRAC)

Contingency Reconnaissance System (CARS)

Able to connect to a local area network.

Use cable to deliver live video imagery in multiple, locations.

Use Service specific ground or airborne UHF, VHF, and UHF/VHF radios for digital message transmission while using the same radios for record traffic.

3.4 Tasks (Objective)

The TCS will be capable of accomplishing the following objective tasks at the completion of the program.

3.4.1 General System

Be hosted in a variety of computers. The initial core of software will be generically written to provide the Level Five (See Figure 3-4) interaction for both Outrider and Predator and establish the architecture for future UAVs. Since not all recipients of UAV information require all levels of TCS capabilities, the software, and software related hardware (accessory chassis), if required, will be developed so that it is scaleable to meet user’s needs. The TCS will prevent users from entering levels of interaction for which they are not authorized by doctrine through software and or hardware configuration.

Support data collection (Levels 1 & 2) from HAE UAVs

Be interoperable with different types of UAVs and UAV payloads across the 5 levels of interaction to include multiple platforms/payloads simultaneously.

Be interoperable with UAVs and UAV payloads operated by allied nations in compliance with NATO Project 35 (appropriate NATO STANAG remains to be determined) across the 5 levels of interaction to include multiple platforms and payloads simultaneously.

Modify existing Joint Integration Interfaces (JIIs), and establish other protocols/standards that will allow compliant air vehicles to pass data to TCSs or TCS interfaced ground data terminals. This will provide UAV manufacturers the standards to which future air vehicles must be built and will allow the government to operate future UAVs from any TCS.

Provide a system level technical architecture for TCS.

Provide a 75% storage capacity over storage used. To meet growth requirements the TCS will be able to add additional storage without a major hardware reconfiguration.

Be capable of increasing throughput 100% over throughput delivered.

3.4.2 Mission Planning

Via operator procedure incorporate vector format and Compressed ADRG (CADRG) maps.

Include flight planning tools for payload search area information such as: visual acuity range due to atmospheric conditions; diurnal transition periods for thermal imagery, and lunar and solar terrain shadowing.

Include tools for importing or creating overlays for fire support coordination measures, airspace control measures, and threats.

Ensure existing or interfaced mission planning systems can satisfy UAV mission planning.

Include collection management tools and message formats for requesting and satisfaction monitoring of HAE-UAV collection activities.

Log the receipt of and provide feedback for HAE-UAV imagery.

3.4.3 Survivability Planning

Provide a method of displaying UAV signature versus threat, before and during flight.

Display overlays or icons of known threat systems and displaying the threat engagement envelopes and associated radar terrain masking for those threats for route planning.

Be capable of storing mission plans and exporting them to force level mission planning systems.

3.4.4 Launch and Recovery

Support incorporation of an automatic launch and recovery system.

3.4.5 Mission Execution / Operations

Be integrated with and operated from tactical and command and control aircraft and submarines.

Enable one operator to control both the UAV and payload for short periods of time.

Display in chronological (priority) order the tasked targets and highlight the target when the payload is on it. This will allow determination of whether the UAV is enroute or actually servicing the number one target. An aid for dynamic retasking.

3.4.6 Imagery Intelligence Processing

Provide aids such as artificial intelligence to alert operators that there is something of interest in the payload field of view and to assist the operators in determining what video segments or digital frames to store/pass on.

Be capable of displaying target symbols in variable sizes

Establish a standard message for air vehicle and sensor interfaces covering frame rate, word size, and data elements.

3.4.7 Data Link Subsystems

Establish Common Data Link (CDL) protocols for frequency, modulation, data formats and data link acquisition.

NATO STANAG 7085 now in development establishes three standard data links:

1) NATO wideband data link United States Common Data Link (CDL)

2) Analog data link (to be determined) No preference has been set but Predator/Hunter C-band Data link is a likely candidate

3) A Broadcast Data Link is being developed by the United Kingdom

3.4.8 Communications Subsystems

Joint Deployable Intelligence Support Systems (JDISS)

Trojan Spirit II

Global Command and Control System (GCCS)

Global Broadcast System (GBS)

DISN 1 and DISN 3 standard communication systems.

Section Four
Operations

4.1 General Overview

The operational objective of the TCS is to get UAV products/ imagery to the warfighter. The warfighter ranges from the troops in the trenches who are fighting today's battle to the commanders at all levels that are planning for the successful outcome of the operation. The TCS supports this effort by providing real time information to enhance the warfighters situational awareness. Operating from squadrons, squadron detachments and companies of the Services the TCS will use existing hardware and software systems to accomplish the mission. In some cases an accessory chassis may be required to enhance the computing power of existing equipment to allow use of UAV products. At the headquarters, assigned personnel will operate TCSs. Using the 5 levels of interaction (Figure 4-1), scaleable functionality is available to the user. However, the launching and recovery (L/R) unit retains final control authority. For operations within a single service coordination on the level of interaction will be IAW service procedures. Coordination on the level of interaction during joint operations will be directed through the JFACC, ATO, or asset allocation process being used in the theater of operations. For joint operations a means of communication (radio, phone, land line, etc.) between the L/R unit and the operating unit will be required in other than Level 1 or 2 (passive UAV product reception) operations. Since not all recipients of UAV information require all levels of TCS interaction, scaleablity will prevent users from entering selected levels through software and or hardware configuration.

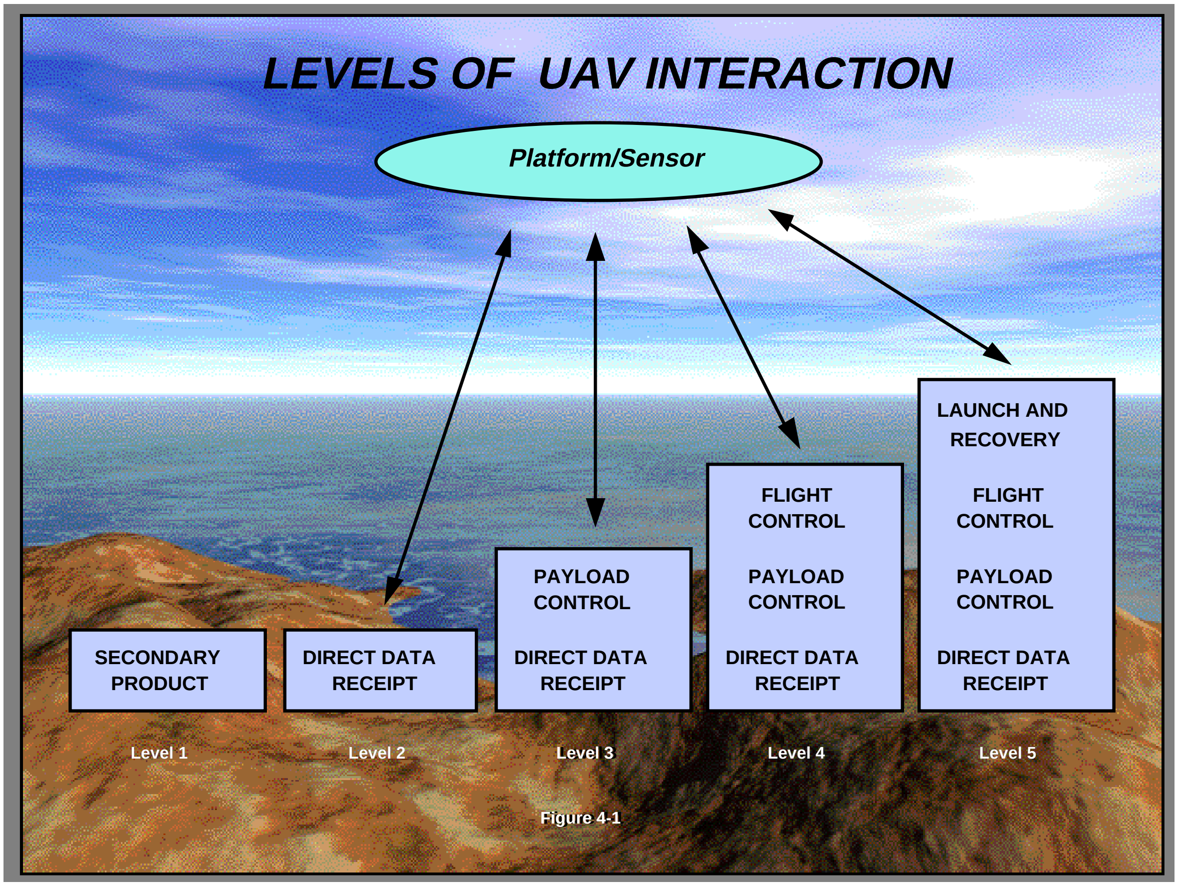

Figure 4-1 Levels of Interaction

The following example demonstrates the TCS interoperability between the Services and their UAV systems in a joint operation. A shipboard UAV detachment launches an Outrider from an LHA-Class ship (Level 5) to observe the beachhead. Marines on board the LHA receive the UAV video via a TCS fed closed circuit television (Level 1). Marines and Sailors on other ships have a direct receipt of imagery via remote video terminals (Level 2). The Air Force at a Forward Operating Location (FOL) 300 miles away launches a Predator (Level 5) to image the location, for engineering requirements, of a future Army Corps operation. To ensure their needs are met, the Army Corps has a direct, real time influence on the payload (Level 3). During this supporting operation, the Predator is also carrying communications and data relays to activate tactical remote sensors in various locations. A TCS controls these sensor relays and feeds them to the respective C^4I processing system (Levels 3 and 1, respectively). In a related operation, a Navy/Marine team passes airborne control of another LHA-launched Outrider to a detachment ashore. At the end of the mission the Outrider is passed back to the embarked detachment (Level 4).

The ultimate operational goal of the TCS is to maximize interoperability and commonality among existing and future UAV systems. By establishing protocols and standards for air vehicles and interfaces for ground data terminals TCS will provide operators a common set of screen menus and displays to operate any air vehicle. It will be transparent to operators what air vehicle is providing the product and directions for air vehicle and payload control will be the same for all UAV systems. Thus the ability to operate UAVs in any operation, conducted by one or multiple services, will dramatically increase their military utility.

Initial Operational Capability (IOC) will be declared when each Service has fielded one production representative TCS with ILS procurement (training, spares, technical publications, support equipment) in place and testing (developmental and operational) completed. The level of performance necessary to achieve IOC requires one system in a final configuration with operators and maintenance personnel trained and initial spares with interim repair support in place. IOC is planned for the third quarter FY99.

Full Operational Capability (FOC) will be achieved when all maintenance and repair support, software support, test equipment and spares are in place and the systems are effectively employed. FOC is planned for fourth quarter FY00.

4.2 Capabilities / Limitations

The Joint Staff, Joint Force Commander and the Services have intelligence, reconnaissance and targeting requirements necessary for the prosecution of a wide spectrum of operations in peace and war. These operations include humanitarian assistance, counter-narcotics, counter-terrorism, peacekeeping, and lesser/major regional military operations. UAV systems offer a relatively low-cost, expendable asset available or dedicated to warfighters that support these needs. However, as shown in Figure 4-2 each UAV system currently has its own unique interfaces with each C^4I processing system and unless something changes this stovepipe approach will be used for future UAVs. The stovepipe approach leads to; higher/increasing costs to develop and maintain individual systems, lack of interoperability for joint operations, each UAV system having to impact on each C^4I system, longer development schedules, and unique proprietary hardware and software for each UAV system. The TCS as shown in Figure 1 provides interoperability and alleviates these limitations by providing a single system to interface between UAVs and C^4I systems. An improvement in one UAV system is automatically applied to all UAV systems when the TCS incorporates the change.

Likewise, a change to interface with a C^4I system need only be made once on TCS to make all UAVs compliant.

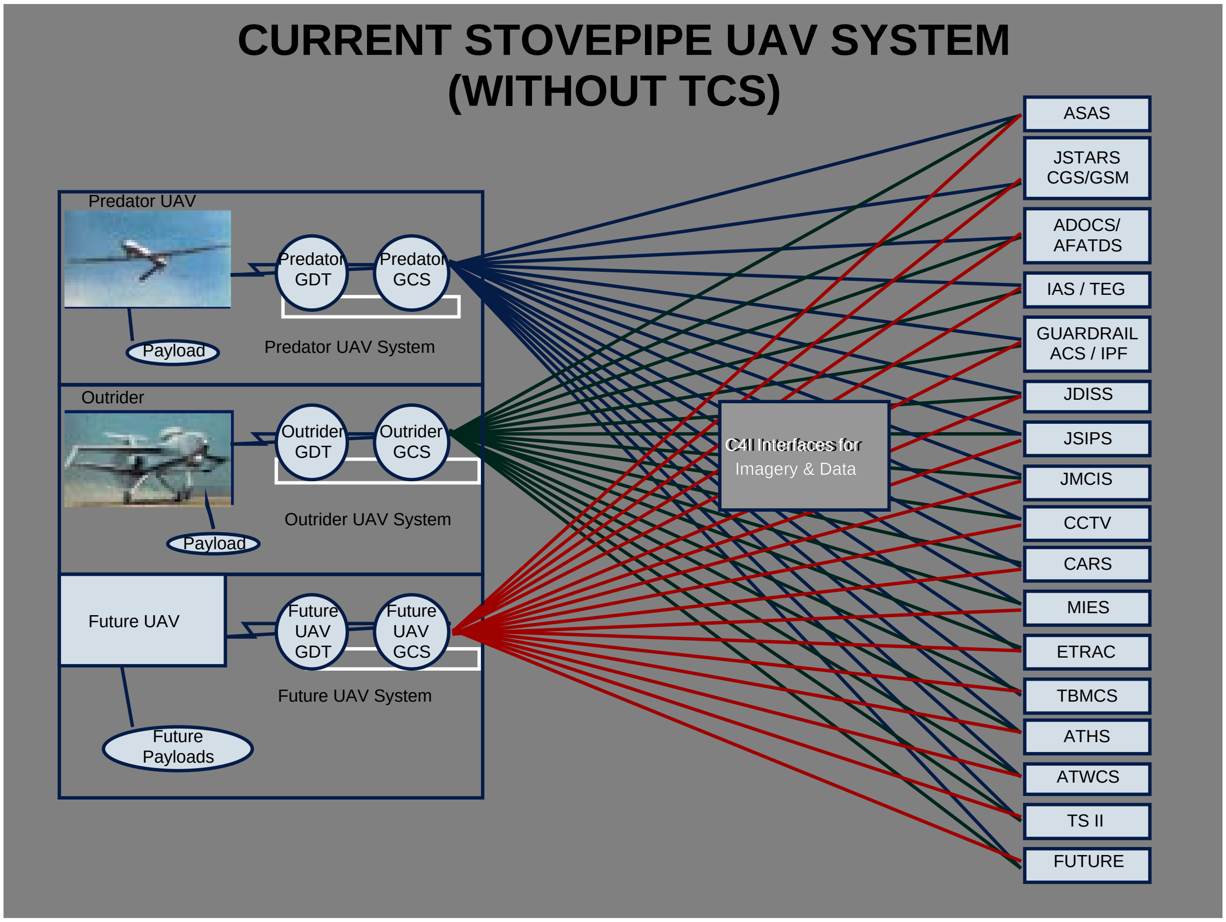

Figure 4-2 Current Stovepipe UAV System

The TCS will be a scaleable, interoperable, deployable equipment/personnel system. This system will be able to deploy to remote operating locations either partially or completely in support of a designated JTF commander and support a wide range of reconnaissance activities from Special Operating Forces (SOF) anti-terrorist missions to major regional conflicts. Because TCS will operate on existing computing systems only the air vehicles, support equipment and personnel may have to deploy. They can operate on the TCS capability already in theater or pre-positioned, thereby saving critical airlift capability. In the case of SOF operations the TCS operators (regardless of service) can be located on ships, land, or airborne to provide the real time UAV product to the SOF team and command headquarters. This operational flexibility is limited only by the creativity of the users.

The TCS provides a collection capability and is not intended as a deployable intelligence center. Collected data is provided to the tactical commander for follow-on threat analysis, situation development, targeting and damage assessment by a deployed or theater intelligence/analysis center. Depending on available communications architecture in the theater, UAV products in the TCS may be simultaneously transmitted via satellite to the JTF commander, the theater commander and to CONUS (e.g., NMJIC).

4.3 Organization

Each Service will align TCS capability within their existing UAV units. Use of these systems for service operations, exercises and demonstrations will be as directed by each service. TCS capability located in headquarters will operate from the intelligence section. Theater CINCs requiring TCS and UAV assets for operational missions will request support from the Joint Staff J2/J3 (operations) via message to the Joint Reconnaissance Office. The Joint Staff, in conjunction with USACOM, validate the requirement. Upon JCS approval, a TCS capable UAV detachment will be chopped by USACOM to the OPCON of the CINC or supported JFC.

For peacetime joint exercises and training, USACOM will coordinate requests from other theater CINCs. Deployment requirements will be coordinated by JCS, CINCUSACOM, JPO, operating service, and the receiving theater CINC.

The JFC provides centralized direction of air operations normally through the Joint Force Air Component Commander (JFACC). The JFC will establish the assets and procedures over which the JFACC will direct air tasking. TCS controlled operations must be integrated into the overall airspace control plan (ACP) developed by the airspace control authority (ACA)(most likely the JFACC). This ACP is then approved by the JFC. Manned aircraft flight through or in TCS controlled UAV flight routes and altitudes is not restricted, however, careful planning and notification must be made to all concerned regarding UAV flight routes to prevent a mishap.

In single service operations the responsible airspace management authority will be provided TCS controlled UAV flight plans and will coordinate them accordingly with other flights in the area of interest. In these type operations, controlling Outrider air vehicles flight activity is normally in military controlled airspace and requires no civilian agency coordination. If Predator air vehicles are utilized that are launched / recovered outside the military controlled airspace, coordination/compliance with appropriate civil (FAA, ICAO) agencies will be required and accomplished by the L/R TCS.

4.4 Basing/Prepositioning

TCS basing will follow Service UAV unit and command echelon plans as discussed in section 6.2 Force Structure. Transportation in theater for Army and Marine Corps systems will be by ground transport, air, or rail. For the Air Force transportation to the theater will be by air. When in theater, the USAF TCS must be capable of being moved around an established air field.

4.5 Deployment/Redeployment

The TCS will be transported into the theater as an organic component of the operational UAV system being deployed. Because TCS will be resident in existing service computing systems it will normally already be available in the area of interest and ready to operate upon deployment of the air vehicles. Therefore, critical airlift assets can be reduced during deployment and redeployment. In the event the gaining theater does not have TCS assets a TCS asset will be identified by the JCS and ACOM and deployed with the air vehicles, support equipment, and personnel.

4.6 Theater Responsibilities

TCS operated air vehicles will be IAW the CONOPS developed for the type air vehicle in use. Theater responsibilities will include the housing, security, messing, health care, and logistics support provided other theater personnel. The TCS brings no unique responsibilities for the gaining CINC.

4.7 Mission Tasking/Planning

The JFC or the Service (in the case of a single service operation) will establish coordination and tasking policy in accordance with the current rules of engagement and appropriate directives. The JFC will determine apportionment of air assets, while the JFACC will determine allocation of TCS controlled air assets. Based on the J2 collection plan, the TCS detachment will submit a flight plan to the JFC and/or JFACC for deconfliction. Mission data on preplanned sorties will be contained in the air tasking order (ATO). Requests for immediate (unplanned or dynamic retasking) missions will be coordinated through the JFC, using normal air request procedures. As required by the type air vehicle in use, a liaison officer (LNO) familiar with the UAV capabilities/operation could assist the JFC/JFACC in operational planning and deconfliction efforts.

Request for information (RFI) and essential elements of information (EEI) for TCS data will be handled within the existing joint or service RFI architecture by the supported command. RFI will be passed to the JTF J2 for data collection management and tasking. The J2 will be responsible for coordinating and prioritizing RFI based on the Commander's EEI's.

Sensitive Reconnaissance Operations (SRO) procedures must be considered. Chairman of the Joint Chiefs of Staff (CJCS) Instruction (CJCSI 3250.01) exists for non-wartime DoD sensitive airborne reconnaissance operations by either manned or remotely controlled mobile platforms. SROs are deemed those missions which, by virtue of their collections objectives, means of collection, or area of operation (AO), involve significant military risk or political sensitivity. The applicability of SRO policy guidance to TCS reconnaissance operations must be addressed in the Operational Order (OPORD)/Operations Plan (OPLAN) for each deployment. In general reconnaissance operations in support of a JCS-directed joint operation involving the designation of a JTF are exempt from SRO policy. For other peacetime operations, DIA (or the newly formed NIMA?) will manage and coordinate proper use requirements with the Joint Reconnaissance Center (JRC) when notified by a theater or operational commander of impending/emerging reconnaissance requirements for assets under his control. NIMA is responsible for developing Consolidated Instructions (CI) for the processing, exploitation and dissemination of imagery and imagery derived products resulting from UAV SROs.

4.8 Employment

The TCS provides operational flexibility to the gaining unit through the use of existing/in place computing systems, TCS trained personnel already in theater, the ability of individual services to pull down UAV products and expedite dissemination within Service C^4I systems, and a interoperable UAV capability between the Services that expands joint employment opportunities. Employment considerations/procedures will be driven by the type UAV(s) employed, the operating area (FAA/ICAO involved), participating Service(s), and rules of engagement to mention only a few. The TCS will operate the selected UAV based on the UAV's established concept of operation. As TCS matures toward the objective system, unique and new capabilities available through TCS should be included in the appropriate UAV CONOPS. Figure 4-3 illustrates TCS Joint operations. Similar Service illustrations are provided in paragraph 4.10.

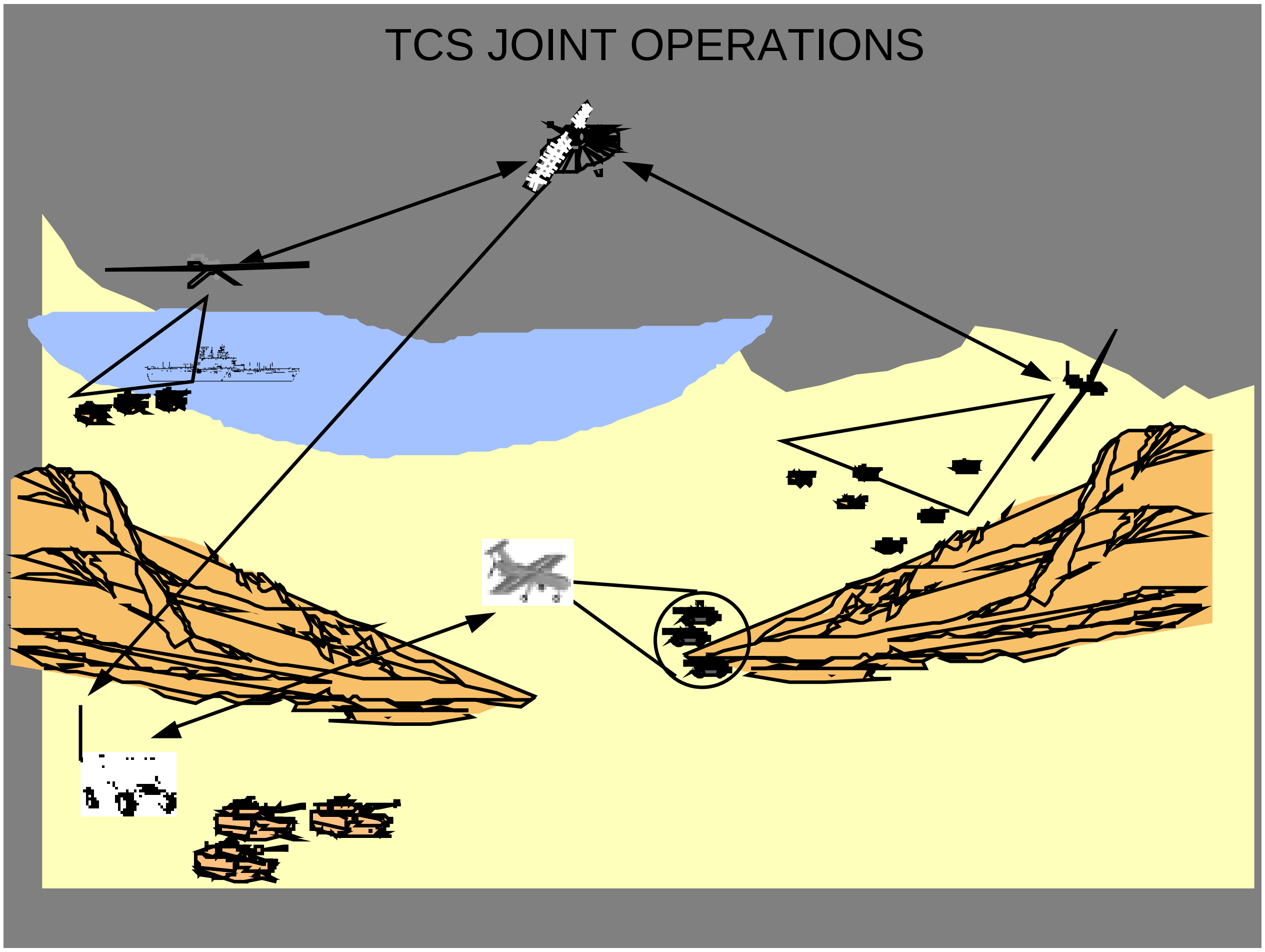

Figure 4-3 TCS Joint Operations

The Outrider UAV system consists of: 2 GCSs, 2 GDTs, 1 RVT, 4 AVs, 4 EO/IR modular mission payloads, tactical communications devices, and support equipment. The TCS will provide the same capabilities as the GCSs and RVT and must satisfy the stipulation that man-portable components shall consist of subassemblies that weigh no more than 100 pounds. TCSs will be located in squadrons within the Navy and Marine Corps and companies within the Army and will be able to co-locate with the supported commander. Outrider detachments may be combined for protracted operations or to meet high demand tasking requirements. When Outrider is collecting information, the TCS operator will be able to transmit information via wire connection (local area network, fiber optic cable, etc.) data burst radio transmission, or voice radio. In a semi-fixed location (greater than 24 hours) transmission will often be made by wire. Minimal imagery or data exploitation will take place in the Outrider GCS or TCS. The TCS will be capable of providing five levels of interaction which will enable it to satisfy forward control element (FCE) operations. The FCE concept allows the launch and recovery of Outrider from a rear location with a hand off to the forward location for support of the operation. Land-based TCS operations will be from HMMWVs with standard shelters and trailers while sea-based operations will be incorporated within existing ship's spaces and computing systems. TCS will be capable of supporting 6 Outrider flight hours in a 12 hour period of operation.

The Predator system consists of: 1 GCS, 1 GDT, 4 AVs, 4 EO/IR/SAR payloads, Trojan Special Purpose Integrated Remote Intelligence Terminal (SPIRIT) II (TS II) communications system, and support equipment. The Air Force will deploy Predator as squadron detachments and operate from fixed Forward Operating Locations (FOLs). MAE UAVs will support the missions at varying levels of command and combine to create an interoperable network of UAVs extending from the forward line of own troops (FLOT) to the rear of the second echelon. The MAE UAV will support the theater CINC, or any of the sub-components as directed. Because of its missions and capabilities, the supported commander may be hundreds of miles from the FOL. The ensuing distance places a larger demand on the communications links required of the Predator system. The GCS is equipped with both line of sight (LOS) control for an operating range of up to 148nm and SATCOM relay at greater ranges. Predator normally operates in the 15,000-25,000ft range with a demonstrated endurance of 40+hrs. The long dwell time, provides a stare capability in target areas and the unclassified, raw, high resolution imagery can be transferred in NRT to the operational commander. Unclassified imagery gives the commander an option to share it with international forces. TCS support for Predator will include continuous 24hr operations.

No matter what type air vehicle is used, the level of interaction selected will determine any limitations or lockout of TCS capability. For example, initial use of TCS will require that the launching and recovering GCS or TCS retains final control authority. To accomplish this, critical operational parameters (max/min altitudes, time duration, minimum fuel remaining, lost link direction, etc) must be established and activated in the gaining TCS. Some means of communication (phone line, radio, data link, etc.) between the L/R and gaining TCS is required. In the case of Predator this can be accomplished by allowing LOS operation by the TCS while the L/R site uses SATCOM to monitor the operation. For Outrider, a phone or radio line can be used or the need for final control by the L/R site can be waived based on the ongoing operation. While TCS will initially provide the screens, menus, and control features resident in the Predator and Outrider ground stations in the objective system the need for "hands on" flying of the air vehicle will be overcome through the use of point and click and automatic launch and recovery options. This will ultimately allow TCS operation of air vehicles without pilot qualified personnel. Therefore, TCS will require logic circuits to alert operators of serious air vehicle problems such as icing, engine power loss, etc., and activation of appropriate measures such as lost link return to base. In order to satisfy FAA/ICAO rules during operations in other than military controlled airspace either block altitudes for air vehicles, an active collision avoidance system that automatically directs air vehicles to diverge, radar monitoring, a chase aircraft, and/or the immediate availability of a pilot qualified unit member would be required. The particular option selected will be determined in conjunction with the civilian airspace control agency in the area of operation. Training in operation of TCS should include a section on FAA/ICAO rules and procedures because it is unlikely that UAVs will be operated solely within military controlled airspace.

4.9 Safety Considerations

Lost link instructions should be reviewed for update whenever ad hoc tasking takes the air vehicle from the programmed flight path. If lost link instructions are not updated and the system attempts to go from an ad hoc position back to the first point of the lost link procedure there is a possibility that the route of flight could cross a restricted area, terrain obstacle that was not planned for, or a longer than planned return route that will run the air vehicle out of fuel. The TCS must be capable of adjusting the lost link instructions with the concurrence of the L/R station. TCS automation of this update should include the ability to identify areas not to be overflown, minimum safe altitude in the current area of operations, fuel required to return to the L/R station, and other appropriate warnings as they occur during flight so lost link can be updated immediately when required.

TCS will operate within Federal Aviation Administration (FAA) safety guidelines. The current FAA policy regarding the operation of military unmanned aerial vehicles (UAVs) in the National Airspace System (NAS) is contained in FAA Order 7610.4, Special Military Operations, Chapter 12, Section 9, Paragraph 12-91 (Figure 4-4) below. This criteria was originally developed for cruise missile type vehicles and not specifically for the myriad of UAVs that are currently in the military’s inventory. The FAA is in the process of determining what revisions to the existing criteria are needed in order to more effectively provide the DOD with greater latitude for operating UAVs in the NAS. The FAA may establish the new criteria either by means of a Special Federal Aviation Regulation (SFAR) or Advisory Circulars (ACs) or possibly both.

Only draft generic UAV ACs currently exist. These AC's are not regulatory but are informational and educational tools that provide guidance on safe operating practices. In reality, UAV FAA Airspace Integration efforts have been via operations in military exercises such as Roving Sands 95 and several operational deployments. Operations of UAVs in airspace other than restricted, warning, or positive control airspace has been accomplished under the criteria defined in FAA Order 7610.4, Special Military Operations.

The experience the FAA has gained from ongoing UAV operations will assist the FAA as they develop further criteria for UAV operations. The FAA is considering issuing a Special Federal Aviation Regulation (SFAR) or Advisory Circulars (ACs), or possibly both to define the criteria. Some TCS related subjects that are being addressed in the draft ACs are:

- UAV Design Criteria. Air Vehicle Control Station. "...Station design should facilitate control of the UAV(s) by the internal pilot and provide for unambiguous operations and clear indications of UAV flight status. Design criteria should minimize the potential for human error. All "conventional" flight indications and warnings necessary to ensure safe control of the UAV flight path should be provided. In particular, the UAV internal pilot should be informed of any degraded mode of operations due to any failure, including cases in which there is an automatic switching to an alternate or degraded mode of operation. The control station should include a diagnostic and monitoring capability for the status of the vehicle. Real time, direct communications / surveillance, and data transmission capability should be provided in the absence of failure. For operations in controlled airspace, direct communications with the FAA controlling agency should be incorporated into the air vehicle control station system design."

- UAV Operations. Background. "Because the personnel who operate UAVs in the NAS are located on the ground, a greater degree of supervision and assistance is available to the pilot of a UAV than to the pilot of a manned aircraft. For this reason, the FAA has determined that it is appropriate to allow one pilot in command to exercise authority over several UAVs, under certain circumstances." Transponder. "...Additionally, the transponder should automatically transmit code 7700 in the event that the control link with the AVCS (air vehicle control station) is lost." Right of Way. "...When operating in Class C, D, E (below Class A), or G airspace, UAVs should give way to manned aircraft."

- UAV Pilot Qualification and Training. Background "...the FAA has determined that it is appropriate to allow one pilot in command to exercise authority over several UAVs, each operated by an internal pilot, under certain circumstances.” Pilot in Command. “...During operations in which the UAV is operated by an internal pilot, the pilot in command may be the internal pilot of the UAV or, alternatively, a pilot within the same AVCS who is supervising that internal pilot.” Instructional Flight Experience and Proficiency “...Because a UAV pilot is not subject to all of the types of sensations and feedback available to the pilots of manned aircraft, computer-aided training and simulation should be well suited to providing UAV instruction...”

- UAV Maintenance. Recordkeeping. “a. For each UAV, a logbook should be maintained. In this logbook, the UAV operator should maintain records of all maintenance actions performed.; b. For each UAV, a discrepancy log should be maintained, indicating any discrepancies found during any pre-flight or post-flight inspection, and the status of corrective action taken.; c. The UAV operator should maintain records that allow tracing of each item used in UAV maintenance to the manufacturer of that item, as well as a lot or batch identification of that item.; d. The records specified by the provisions of this paragraph should be maintained until the work done is repeated or superseded, or for a period of 1 year, whichever comes first.”

Again, the above information is from “Draft” Advisory Circulars but indicates the direction FAA is taking on UAVs. Following the development of an SFAR, it is published in the Federal Register and made available for public comments. After the comment period, normally 60 days, the FAA reviews the comments received and includes those ideas that make the SFAR more effective when published as a regulatory criteria.

To date, the FAA has not published the amount of lead time necessary to adequately allow FAA to make a decision as to whether or not requested UAV activity in the NAS will be approved. The coordination process for UAV operations that requires FAA region authorization are lengthy and the mission planners should allocate approximately 90 days from the time of request submission to receiving of an FAA response. It is recommended this process follow the procedures outlined in the current (DRAFT) FAA AC : Unmanned Air Vehicle Operations. The process involves meeting with FAA field facility personnel, FAA regional personnel as well as with area airspace military users. In addition, the mission planners must ensure adequate time is available to complete all of the other necessary coordination; e.g. military units, ATC facilities, special-use airspace scheduling, etc., between the time that FAA authorization is received and the beginning of the UAV operations. Normally, those proposed UAV operations that only require coordination with affected ATC field facility, in lieu of obtaining FAA region approval, can be completed within a 30 day time frame.

With the aid of existing users, FAA ATC field facility personnel and Regional FAA representatives, build the UAV operational concept to and from the operating area. Defined routes and altitudes as well as normal and emergency procedures should be described. The process will normally start more restrictively then ease as the TCS UAV demonstrates its capability to comply with FAA instructions. Understanding this process will reduce conflicts between the TCS UAV operators and the data users.

Should any of the proposed routing include flight outside of restricted areas, warning areas or positive control airspace (Class A or B), it will be necessary to define what quasi method of “see & avoid”; i.e., ground observers, primary radar monitoring , control firing area concept, etc., will be employed which provides a level of safety equal to that provided by a chase plane (for no chase plane operations). Additionally, refer to FAA Order 7610.4, Paragraph 12-91d. For Exercise Roving Sands, this equivalent level of safety was obtained by using the “Controlled Firing Area Concept” (spotters) around the local field and by a military radar unit for the flight operations below 7,500ft. MSL.

Final approval for military operations are obtained from the local FAA Regional authority and not FAA National Headquarters.

Existing Regulations: Within the Federal Aviation Regulations (FAR) there is currently no reference to UAVs. FAA Instruction 7610.4H (Figure 4-4) defines military criteria for operation of UAVs.

Section 9. UNMANNED AIR VEHICLES (UAV)

12-91 OPERATION

Since UAVs do not have see and avoid capability, operation of these vehicles must be rigidly controlled to avoid hazards to other air traffic. Operation of UAVs shall be limited as follows:

a. Within Positive Control Area (PCA)

b. Within restricted areas.

c. Within warning areas.

d. Outside of the above areas, the UAV must be accompanied by a chase plane with direct communication with the controlling source facilities. It is the chase plane pilot’s responsibility to relay potential conflicts to the controlling source facilities and provide changes of heading and altitude to resolve any traffic conflictions. If an alternate means of observing UAV flight is available, which would provide a level of safety equal to that provided by the chase plane, it may be approved at the discretion of the concerned FAA region. This may include visual observation from one or more ground sites, UAV flight monitoring by patrol aircraft, primary radar observation, or the controlled firing area concept. (See FAA Order 7400.2) Operations shall be conducted in Visual Flight Rules (VFR) conditions.

Figure 4-4

In November 1996 the Committee for European Airspace Coordination (CEAC) developed a working paper on "Guidance for UAV Operations, Design Specification, Maintenance and Training of Human Resources". Like the FAA the CEAC guidelines are only advisory at this time. Some applicable CEAC guidelines for TCS consideration follow:

- Communications. "The UAV Pilot-in Command shall initiate and maintain two way communications with the appropriate ATC authorities for the duration of any flight."

- Direct Communications Required. "...The UAV air vehicle control station should utilize a communications architecture that interfaces with existing ATC communications equipment and procedures, so that the fact that the pilot in command is on the ground is transparent to ATC personnel. Upon check-in with ATC personnel, the pilot in command shall request a direct telephone number for the ATC controller for contingency use should radio communications fail."

- Chase Plane Requirements. "...During flights or portions of flights under IFR procedures where a chase plane is utilized, the chase plane shall be incorporated into the IFR flight plan. In such a case, the flight will be classified as a formation flight, and shall have the same right-of-way status as aircraft engaged in airborne refueling or towing."

4.10 Service Considerations

4.10.1 Army

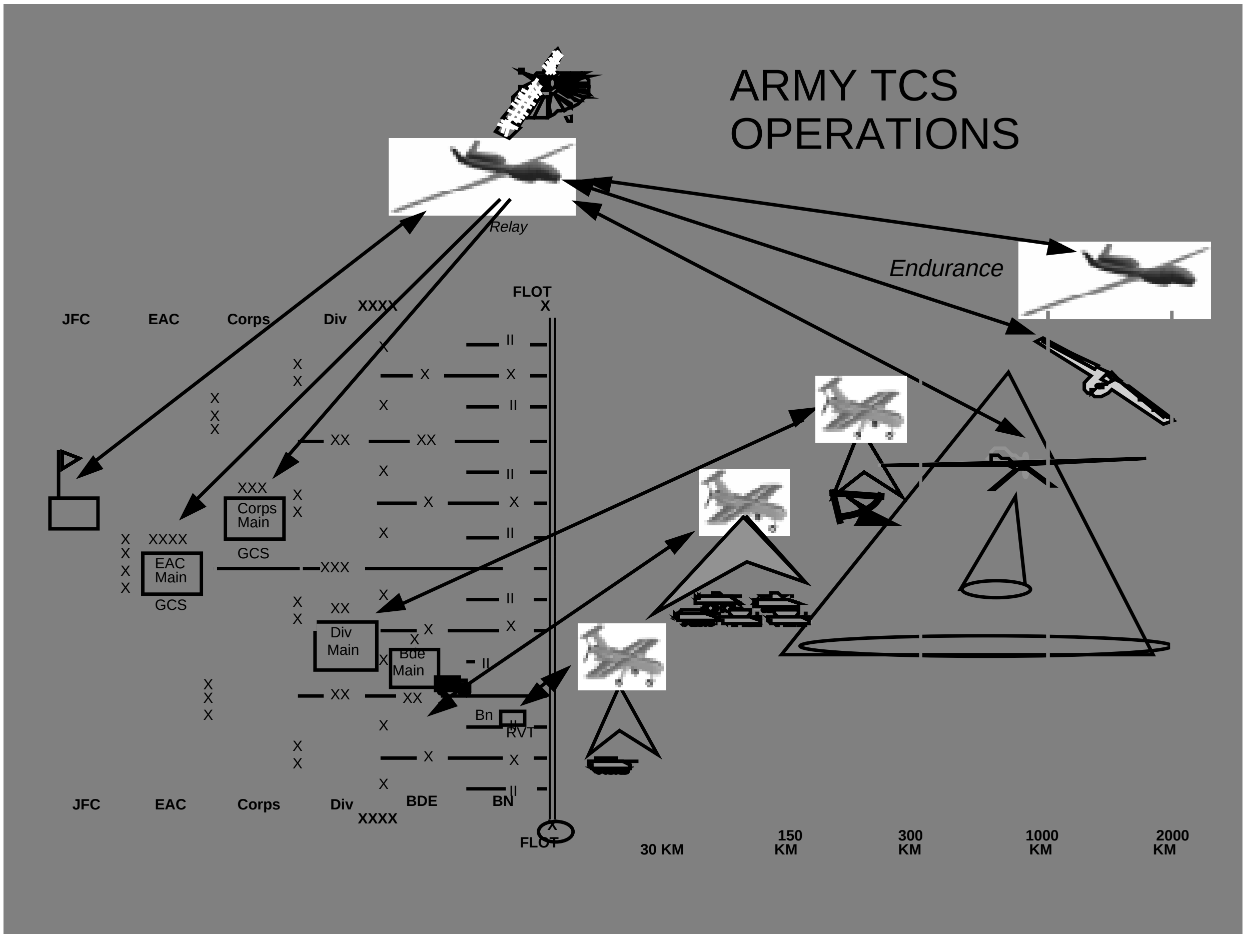

Figure 4-5 TCS Army Operations

4.10.2 Navy

4.10.3 Marines

4.10.4 Air Force

Section Five
Command and Control

Section Six
Personnel/Training

6.1 Manpower

The TCS manpower requirements shall not exceed the Services' guidelines for their respective UAV program. As an operational goal TCS would require no more than two personnel to operate the system at any moment and two maintainers should be able to maintain the TCS system software, computer hardware, communications networks, and associated electrical generation and supply for the system. For short periods one operator may control both the air vehicle and payload. The number of data exploiters, communicators, and supervisory personnel will depend on the UAV used and the theater commander's operational plan.

6.2 Force Structure

Army preliminary estimates require TCS support for 38 Outrider systems to meet active division, brigade, and armored cavalry regiment needs. An additional 24 TCSs will support elements at division and corps.

Navy preliminary estimates requires 12 LHA/LHD ships to be outfitted with TCS control and dissemination equipment and 1 land-based TCS for Outrider (Land-based system will be configured in HMMWVs at VC-6, NAS Patuxent River for training. An additional 88 TCSs will support CV/CVN, LCC, LPD 17, surface combatants, and submarines.

Marine Corps preliminary estimates to meet pre-positioning, war reserve, and expeditionary force requirements are for TCS support of 11 Outrider systems. VMU-1 will have 4 systems; VMU-2 will have 4 systems; and there will be 3 Outrider systems on maritime pre-positioned ships. An additional 6 TCS will support JSIPS-TEG and JSTARS CGS.

Air Force preliminary estimates call for 12 TCS to support the Reconnaissance Squadrons at Indian Springs, Nevada.

Training support at the Joint DoD UAV Training Center, Ft. Huachuca, AZ will require an undetermined number of additional TCSs.

6.3 Formal Training

Training shall be balanced between institutional, New Equipment Training (NET), and unit training. Instructor and key personnel training will be conducted. TCS equipped units will receive NET as the system is fielded and training devices will be used for the institutional training base. Training will be conducted in both garrison and field environments in both individual and collective modes.

6.4 Continuation Training

TCS provides sustainment training for operators and maintainers through the capability for incorporation of embedded/add-on interactive training with self-paced instruction, duplicating air vehicle flight performance characteristics, capabilities, and limitations. In the case of Outrider the TCS will be compatible with the U.S. Army Intelligence and Electronic Warfare Tactical Proficiency Trainer (Multiple UAV Simulation Environment--MUSE).

6.5 Service Considerations

6.5.1 Army

Army air vehicle operators will be MOS 96U, technicians and mechanics will be MOS 339 and 52D respectively.

6.5.2 Navy

The Navy will use Naval Enlisted Classification (NEC) codes 8362, 8364, and 8365 for air vehicle and payload operations. Mechanics and technicians NEC codes are 8361 and 8363 respectively.

6.5.3 Marines

Marine Corps air vehicle operators will be MOS 7014, technicians and mechanics will be MOS 6314 and 6014.

6.5.4 Air Force

Air Force Specialty Code (AFSC) for air vehicle operators will be 11RXX and 12RXX. Imagery payload operators will be AFSC 1N1.

Section Seven
Logistics

7.1 General

Each Service will support the TCS as part of the UAV system which is organic to them.

7.2 Support Systems Requirements/Responsibilities

Support for the TCS will be IAW the Integrated Logistical Support Plan (ILSP) and the maintenance concepts and policies of the individual Services. Standard tools, TMDE, repair parts, and lubricants will be used. Exceptions will be considered on a case-by-case basis. To the maximum extent possible, general purpose test equipment (GPTE) and common tools resident in each Service will be used to perform all corrective and preventative maintenance at all authorized levels of maintenance. Tools and test equipment required but not resident in each Service inventory will be identified as special tools and special purpose test equipment (SPTE) respectively and kept to a minimum.

A TCS support and fielding package will be developed and available for operational testing.

TCS hardware will be mounted and/or ruggedized to withstand inter and intra theater movement. If containers are provided, they must be reusable and enable the operators to set up equipment within the established timelines for the UAV system being used.

7.3 Maintenance Environment

TCS maintenance will be IAW each Services' UAV maintenance concepts and procedures.

7.4 Maintenance Concept

7.5 Service Considerations

7.5.1 Army

The U.S. Army will use the established maintenance practices for Communication, Intelligence and Electronic Warfare (IEW), Aviation, and Ground Systems.

7.5.2 Navy

The Naval Aviation Maintenance Program (NAMP) and Aviation Supply System will be used.

7.5.3 Marines

Tactical UAV systems and the TCS will be supported the same way as a Marine Corps squadron with detachments. Equipment such as the TCS specifically related to flying the UAV will fall under the NAMP.

7.5.4 Air Force

The TCS maintenance concept must support the Air Force concept of “Lean Logistics”. The objectives of this concept include maximum use of rapid transportation, minimum turn around times for repair, and a two level maintenance concept at Forward Operating Locations (FOL).

Section Eight
Intelligence

8.1 General

The TCS is designed to be scaleable and tailored to a wide range of users. The TCS will frequently control a tactical UAV in direct support of a Fire Support Element (FSE). In this case the tasking and reporting chain will be short and direct, receiving verbal commands and responding with verbal reports. When in direct support of an FSE, a broader intelligence support mission may not exist or will be of secondary importance. Imagery exploitation will be limited to the screening capabilities provided by TCS work-stations and the training of assigned personnel.

In other cases, the TCS will control a UAV on an intelligence gathering mission. Collection management for intelligence collection is described in paragraph 8.2 below. Intelligence exploitation will be accomplished primarily in Theater or Service tactical exploitation elements. See CIGSS paragraph 8.3 below. The routine viewing of imagery will constitute a screening function for later processing. The TCS operators will have a limited capability to read out and report on Predator, Outrider or Global Hawk imagery. TCS imagery products may be verbal or text reports, freeze frame images, or short full motion video clips. The primary activity will be to route collected data to designated exploitation/analysis centers. For imagery, those centers are the Theater JICs (JAC in EUCOM and AIC in USACOM) or the Services CIGSS Elements[Army- ETRAC/MIES, Navy - JSIPS-N/DIWS(A), Marines - TEG, and Air Force CARS].

Any CIGSS element should be capable of loading TCS software on their mission equipment and assume TCS functionality to include receipt of imagery directly from the sensors, control of the sensors and control of the UAV.

This section primarily treats imagery. Several other payloads to include SIGINT and MASINT sensors, electronic warfare, mine detectors and laser designators are being planned for the family of tactical UAVs. This document will be updated as concept of operations or ACTDs for these additional payloads are developed.

8.2 Collection Management

Collection management responsibilities generally reside with the echelon of command that holds Operational Control over the air vehicle. The TCS is designed to control the platform and sensors for Predator, Outrider and all future tactical UAVs and to receive selected images from the HAE-UAVs, Global Hawk and Dark Star. A TCS will serve the needs of Army, Navy, Marine Corps, or Joint Commands. As such, collection management practices and procedures will vary based more on the echelon of command to which the UAV and TCS are assigned than by Service with operational command authority. At lower echelons of command, TCS will serve the needs of direct fire support elements. In this situation collection management procedures are very simple; sensors will be employed according to verbal or written orders of the immediate tactical commander.

When TCS is controlling a Predator serving a Joint Commander, collection management procedures will be directed by the appropriate Unified Command. The Daily Aerial Reconnaissance Syndicate (DARS), under the direction of the assigned J2, employs the resources of the JIC and will make recommendations on missions and priority of targets for reconnaissance assets. Membership in the DARS includes JFC staff and component command representatives and is led by the J2's collection manager and chief of targets. Request for data will be handled within the existing Request For Information (RFI) architecture. RFIs will be passed to the J2 collection manager for coordination and prioritization based upon the CINC's prioritized essential elements of information (EEI). For integrated collection requirements, UAV operations will be coordinated with other collection platforms in Theater. For NATO or other coalition operations a similar process may be established to coordinate the collection requirements and collection activities of all national Services.

Collection authority resides with the echelon of command holding Operational Control over the platform. When an echelon of command can not satisfy all collection requirements with organic resources a request for information or a request for collection may be passed to a senior, subordinate or collateral command. The term RFI is generally restricted to a subordinate command's request for support to a senior command. The term Advisory Tasking frequently used in the SIGINT community has also been adopted for imagery requests. Advisory Tasking is when a senior command requests collection support from a subordinate command. Advisory Tasking is a request not an order; final authority for directing activities remains with the echelon assigned operational control of the air vehicle.

TCS will receive and store HAE imagery. (See paragraph 9.3 and figures 9-2, 9-3, and 9-4 for details) When compared to the HAE capacity, the TCS will have limited storage capability. The TCS will serve tactical commanders who typically have very dynamic collection needs. These features create a special case for collection management. Through the routine collection management procedure described above, the HAE MCE will receive tasking requests from the Theater J2 up to 24 hours prior to mission execution. These collection tasks will provide the HAE with specific collection and dissemination instructions. Through the DDE system (also see section 9.3.1) TCS operators will have an ability to communicate directly with the HAE-MCE crew. Within the guidance provided by the JFC, the HAE-MCE crew will accept and act on TCS requests for collection changes.

8.3 Product Exploitation Concept

The primary function of the TCS is to provide a common command and control station for the family (includes Predator) of tactical UAVs. In compliance with the TCS ORD, TCS will receive, store and disseminate High Altitude Endurance UAV imagery. Intelligence exploitation of UAV imagery will be accomplished primarily by the Service-developed tactical exploitation systems. TCS will have an imagery screening capability. Many tactical missions use UAV collected imagery directly without intelligence exploitation. For these missions the TCS will disseminate video clips or freeze frame imagery directly to targeting or command and control facilities. One example is the Joint STARS Common Ground Station. A first level of exploitation may occur in either the TCS or CGS.

TCS operators will be required to perform an imagery screening function. They will use the TCS Image Product Library (IPL) software to query, browse, retrieve, view, and perform other functions facilitating access to the NIMA Library holdings. These holdings are intelligence imagery, Mapping, Charting, and Geodesy (MC&G) imagery, motion imagery (video) , products derived from those imagery sources, and other files which are put into an NITF 2.0 format. IPLs with Common Client Software will be fielded to a wide variety of users requiring access to the NIMA Library holdings while IPLs with Server Software will be provided to sites requiring storage of processed imagery or generated products prior to dissemination to users requesting those materials. TCS is one of the ground stations requiring imagery storage prior to dissemination to another IPL in an Imagery Exploitation System (IES), such as ETRAC or CARS. TCS operators will monitor the continual flow of video imagery for targets of interest, and select short video clips and freeze-frame images for storage in the TCS IPL or for dissemination to users. The screening operators may be expected to recognize and identify target signatures, count presence of ground vehicles, detect movements or other changes in target status.

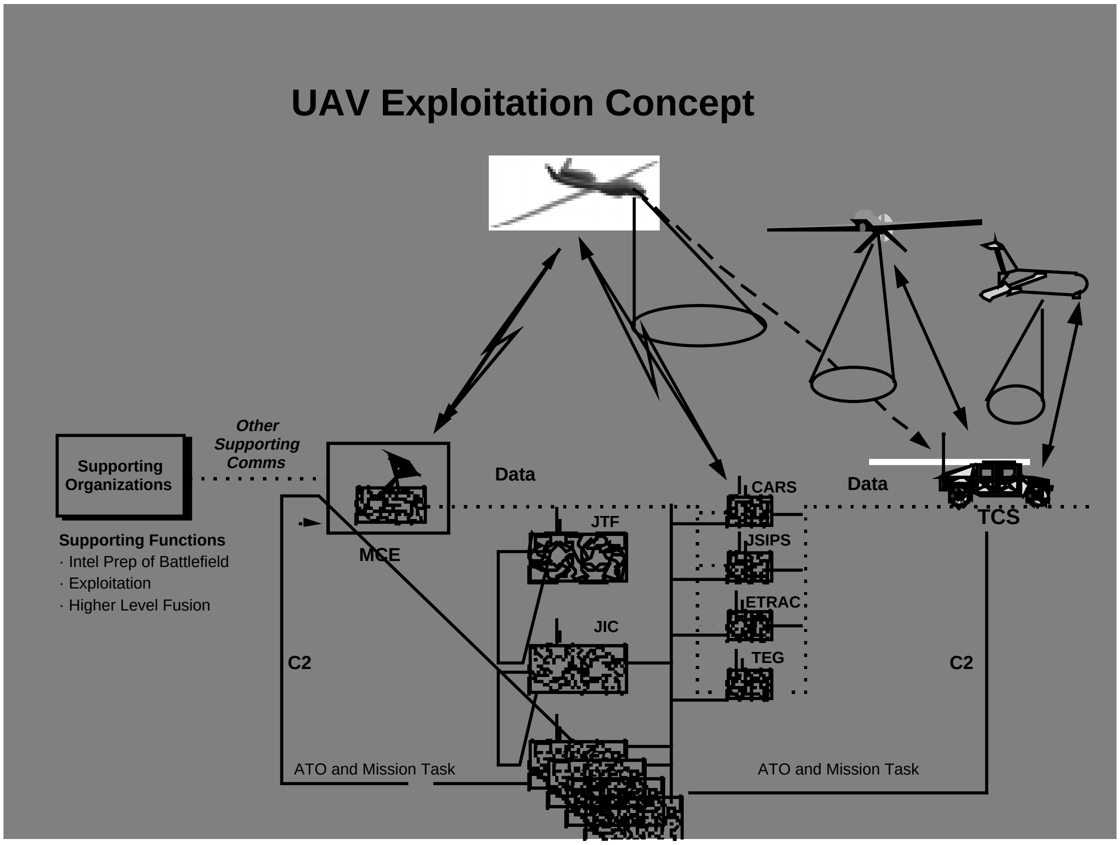

Figure 8-1 Exploitation Concept

Figure 8-1 above is an adaptation of a graphic used in the HAE CONOPS to describe HAE-UAV exploitation. The primary product from both the HAE-MCE and from the TCS is a wide band data stream to a designated Theater or tactical exploitation center. Each Service has developed an intelligence exploitation center that meets its unique needs and serve Joint command requirements. CIGSS will migrate these earlier systems into a standard or common processing format. Both the HAE-MCE and TCS have an ability to provide selected image frames directly to operational users via JDISS, Trojan Spirit or Global Broadcast System. In addition, TCS has the capability and responsibility to provide an imagery screening function and do a first phase imagery analysis.

A central tenet of the TCS concept of operations is compliance with the DARO architecture and the Services’ intelligence support doctrine. Compliance with both DARO and Service guidance is essential to achieve interoperablity with Service command structures and DARO developed ISR infrastructure. The Common Imagery Ground/Surface System (CIGSS) is a series of standards determined by the DARO and National Imagery and Mapping Agency (NIMA). TCS will use CIGSS Standards and, where appropriate, CIGSS components. All TCS imagery products will be disseminated in the National Imagery Transmission Format Standard 2.0 (NITFS 2.0). TCS data storage will use the Imagery Product Library standards. Video will be transmitted using MPEG 2.0. Figure 8-2 is referenced from the CIGSS Acquisition Strategy Handbook and illustrates the standard CIGSS components and elements. Paragraph 8.5 illustrates how TCS will pass imagery to each of the Services through the Service CIGSS Element.

Any one of the CIGSS elements should be capable of loading TCS software on their mission equipment and assume the functionality of a TCS to include receipt of imagery directly from the sensors, control of the sensors and control of a tactical UAV.

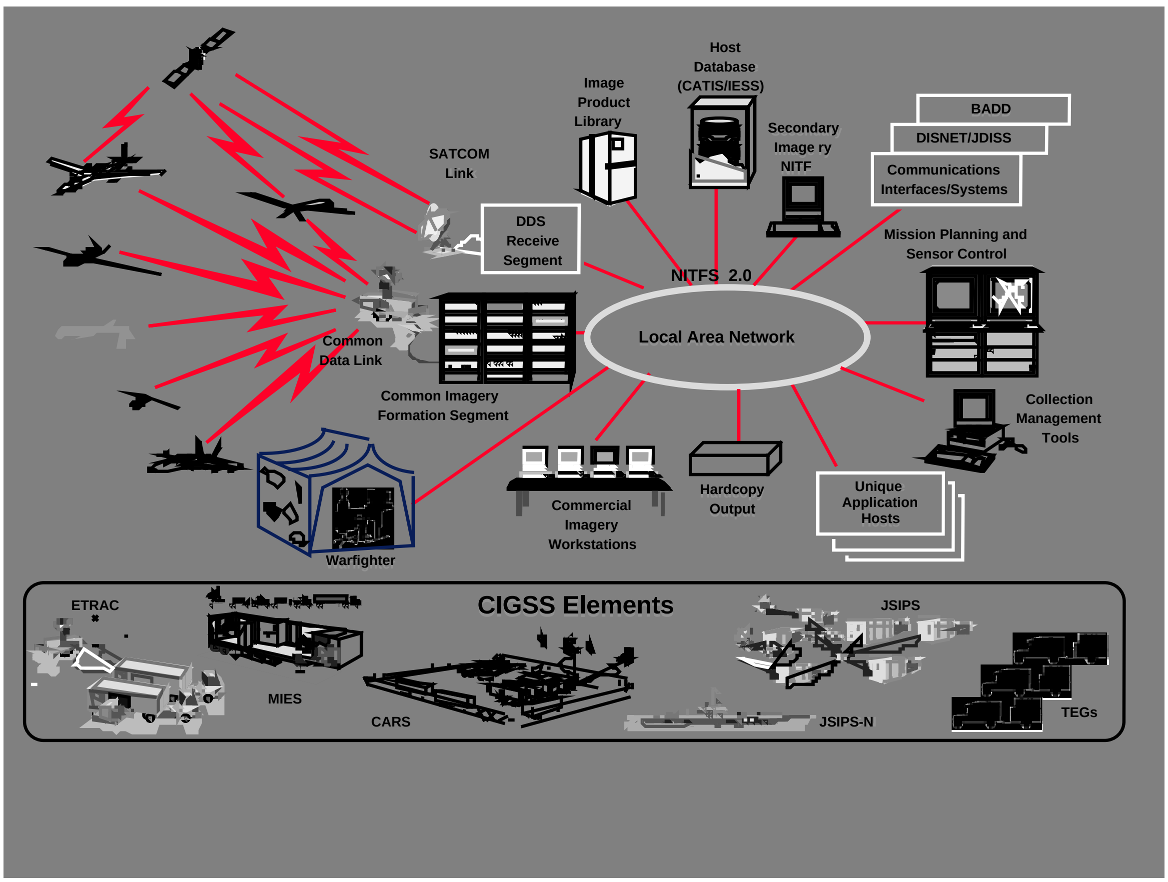

Figure 8-2 CIGSS Architecture

Figure 8-2 illustrates the DARO and NIMA CIGSS architecture. The upper portion of figure 8-2 illustrates CIGSS standard components. Where practical these components must be used. CIGSS components may be in a distributed environment or may be collocated in a central center. Imagery dissemination on the local or wide area network (LAN/WAN) is to be in National Imagery Transmission Format, (NITFS) 2.0.

At the bottom of figure 8-2 are illustrations of the Service exploitation elements that are migrating toward full compliance with CIGSS standards. ETRAC and MIES are part of the Army’s Corps Intelligence architecture. They will be replaced by the multiple source Tactical Exploitation System (TES), ETRAC is primarily an imagery processor with limited exploitation capability, MIES is the Army’s exploitation system. JSIPS, and elements of JSIPS are being fielded in the Air Force, Navy and Marine Corps. JSIPS-N, like ETRAC is primarily a radar imagery processor. Navy exploitation takes place in the Digital Imagery Work Station (Afloat) DIWS(A), TEG is a small, highly mobile JSIPS product for imagery processing and exploitation.

8.4 Product Dissemination

TCS will disseminate imagery reports and products over a wide range of communication systems. TCS is being designed as an open system; the basic tenet of the TCS Concept is compatibility with all the Services’ C4I infrastructures. TCS will be GCCS compatible and can communicate over DISN 1 (Theater secret level net-work) or DISN 3 (Theater SCI level network). Typical tactical networks in which TCS will be compatible include Trojan Spirit II, JDISS/JWICS, and the Global Broadcast System. In many applications, the TCS will have direct hardware connectivity to the supported tactical commander.

The IPL integrated in the TCS will serve as an imagery file server buffering processed primary imagery downlinked from the UAV prior to being transmitted to the IES. TCS imagery will be motion imagery (video) consisting of long time-frame scenes of motion imagery, short clips excerpted from a mission, or single frames. The imagery will be automatically fed into the IPL from the Screener Workstation in the TCS or directly from the image processor into the IPL if desired thus bypassing any type of quality control normally performed at the TCS workstation. In either case imagery will then be disseminated to users outside the TCS, such as an IES, via two dissemination options, “Imagery Push” and “Imagery Pull”.

A user(s), at an IES or other site, requiring imagery will establish an imagery request or “Profile” specifying imagery to be automatically sent (Smart Push) from the TCS to the user’s IPL and/or other NIMA library as designated in the Profile. In addition, a TCS operator, knowing a priori a specific user’s imagery dissemination requirement, can manually send (“push”) the appropriate imagery to the user(s).

A user(s), at an IES or other site, requiring imagery will query a specific TCS site(s) to determine if motion imagery needed to fulfill an exploitation requirement has been collected. When that imagery is found, the user will request the imagery be disseminated (“pulled’) from the source TCS’s IPL to the user’s IPL.

8.5 Service Considerations

8.5.1 Army

Figures 8-3 and 8-4 are a simplified illustration of how the TCS may support Army operations and intelligence. Figure 8-3 Illustrates current Army Corps Intelligence capabilities using ETRAC and MIES. The Tactical Exploitation System (TES) is included to show planned connectivity. ETRAC is the Army’s CIGSS element. Current ETRAC processes U-2 ASARS II imagery and will process HAE, Global Hawk and Dark Star SAR imagery. Exploitation takes place in Mobile Imagery Exploitation Systems (MIES). TCS operators will screen incoming video images from Predator or Outrider and route imagery, as tasked, to ETRAC for future exploitation. Exploitation reports are released out of MIES and become one of the sources for the All Source Analysis System (ASAS). ASAS is the Army principal intelligence data handling system. ASAS will be located at Corp, Division, and some Brigades and provide the latest available information to battlefield commanders. Images will be available to tactical commanders by pulling selected images from local, theater, or national Imagery Product Libraries (IPL).

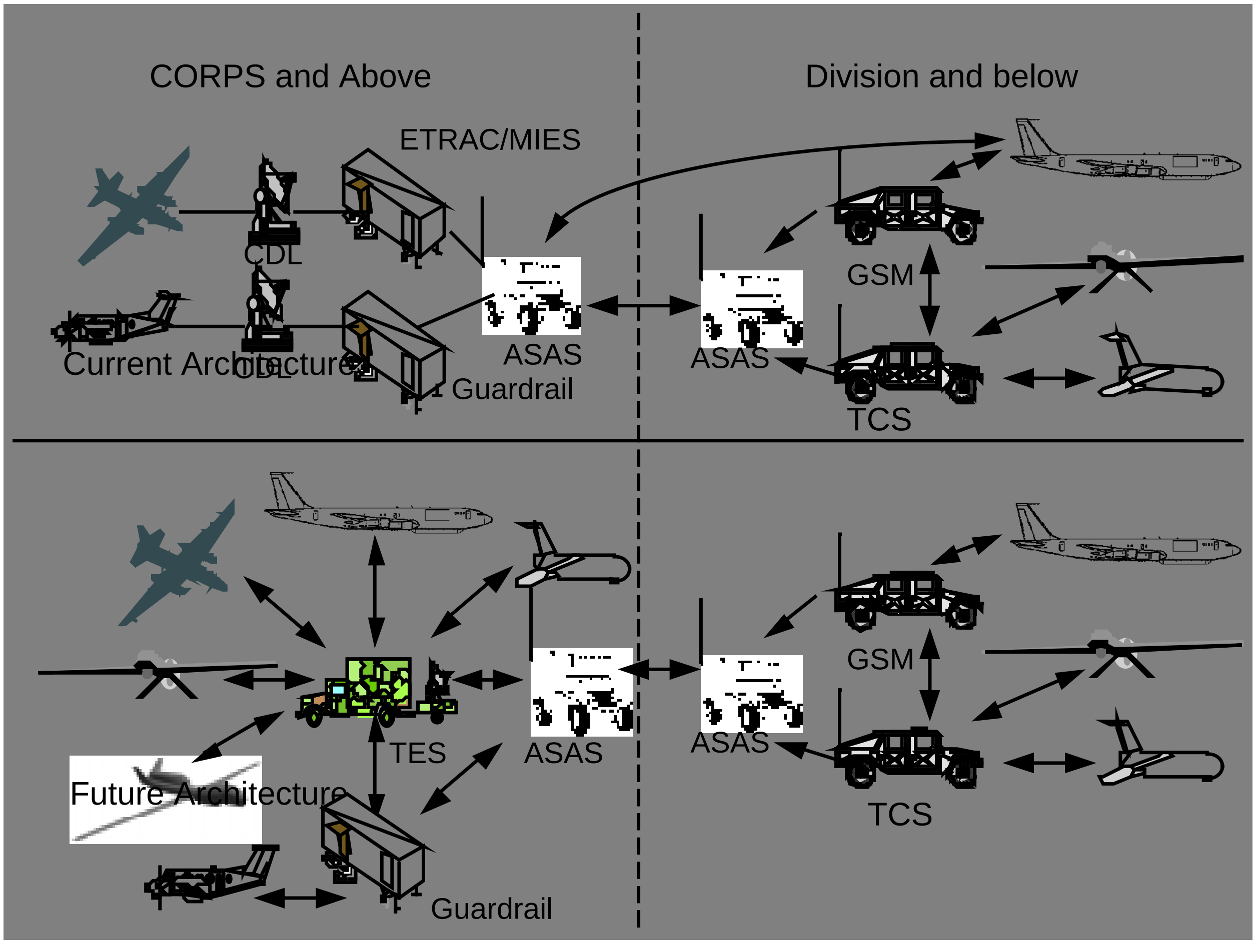

Figure 8-3 Army Intelligence Capabilities

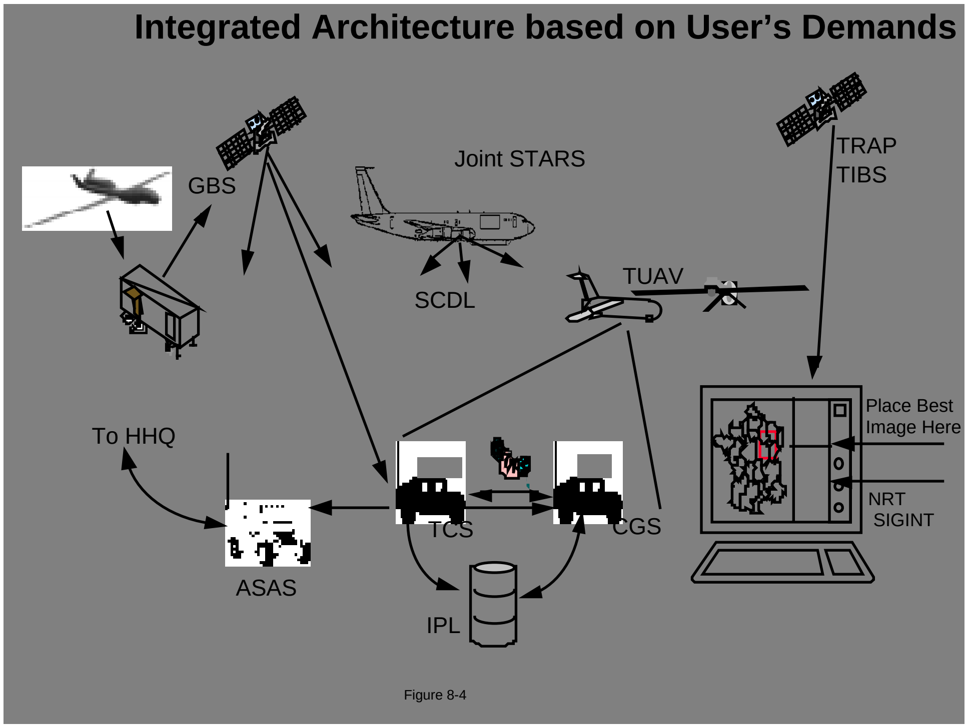

Figure 8-4 User Demand Integrated Architecture

Tactical UAVs controlled by TCS may be deployed with all Divisions, Brigades and Battalions. These UAVs may have a broad range of functions. A function of particular interest is TUAV support to the FSE and Joint STARS Common Ground Station (CGS). CGS is a two man operation which provides targeting support to FSE. TCS operators will provide CGS with verbal reporting, freeze frame images and short clips of video. A CGS operator receiving Joint STARS MTI products has a large area of responsibility. Tactical UAVs have a narrow field of view; it is highly unlikely that the TCS operator will always be synchronized with CGS. One concept being discussed is to design the capability into the CGS to automatically pull desired images from the TCS IPL storage. The CGS operator may use a point and click command to indicate a grid coordinate of interest. The IPL in the TCS would provide the last image taken of this area. TCS operators are expected to be in communication with their FSE and the Joint STARS CGS at the same level of command. TCS operators may respond to verbal requests to change the UAV flight track or sensor tasking.

T-UAV and Predator images could be transmitted to the CGS and TCS simultaneously if both vans are within the data link footprint.

8.5.2 Navy

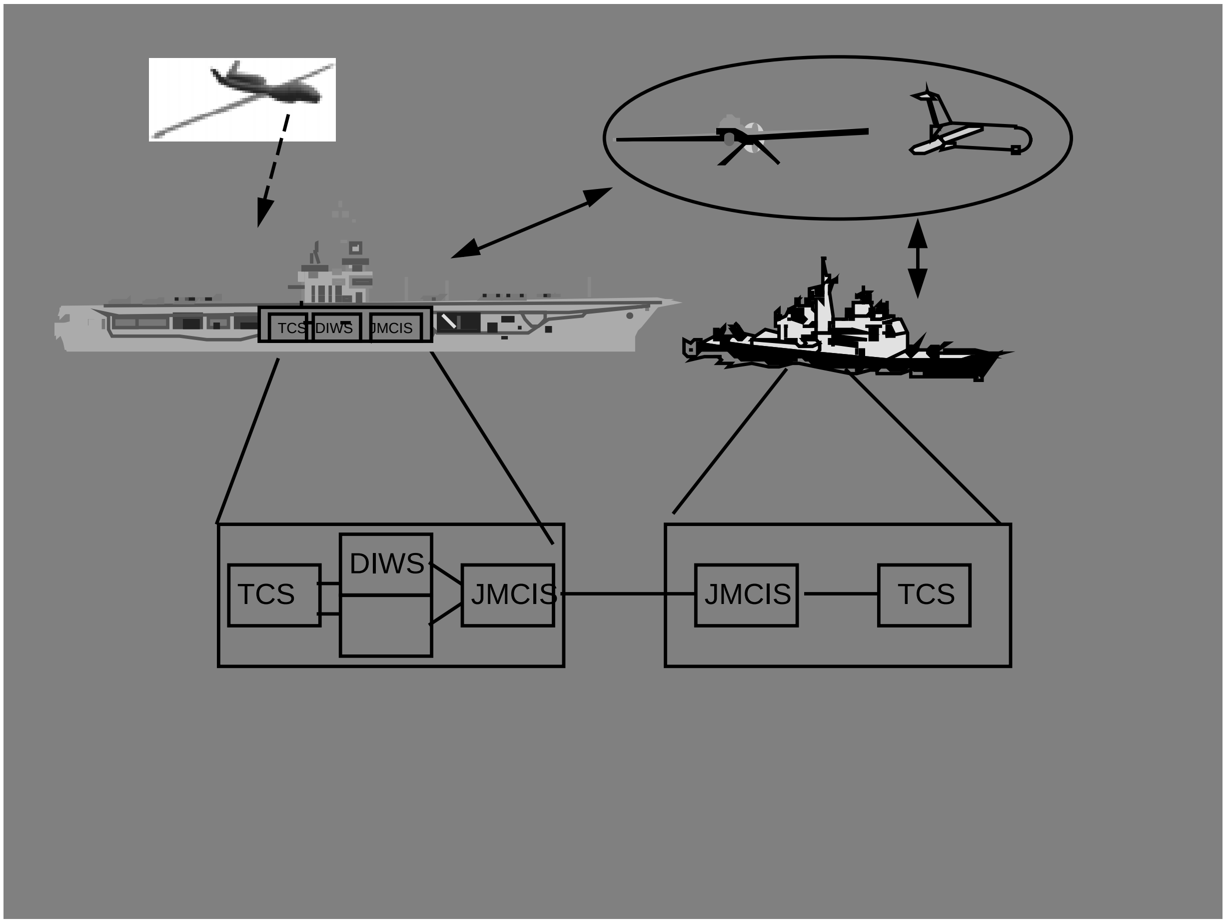

Figure 8-5 Navy UAV Connectivity

8.5.3 Marines

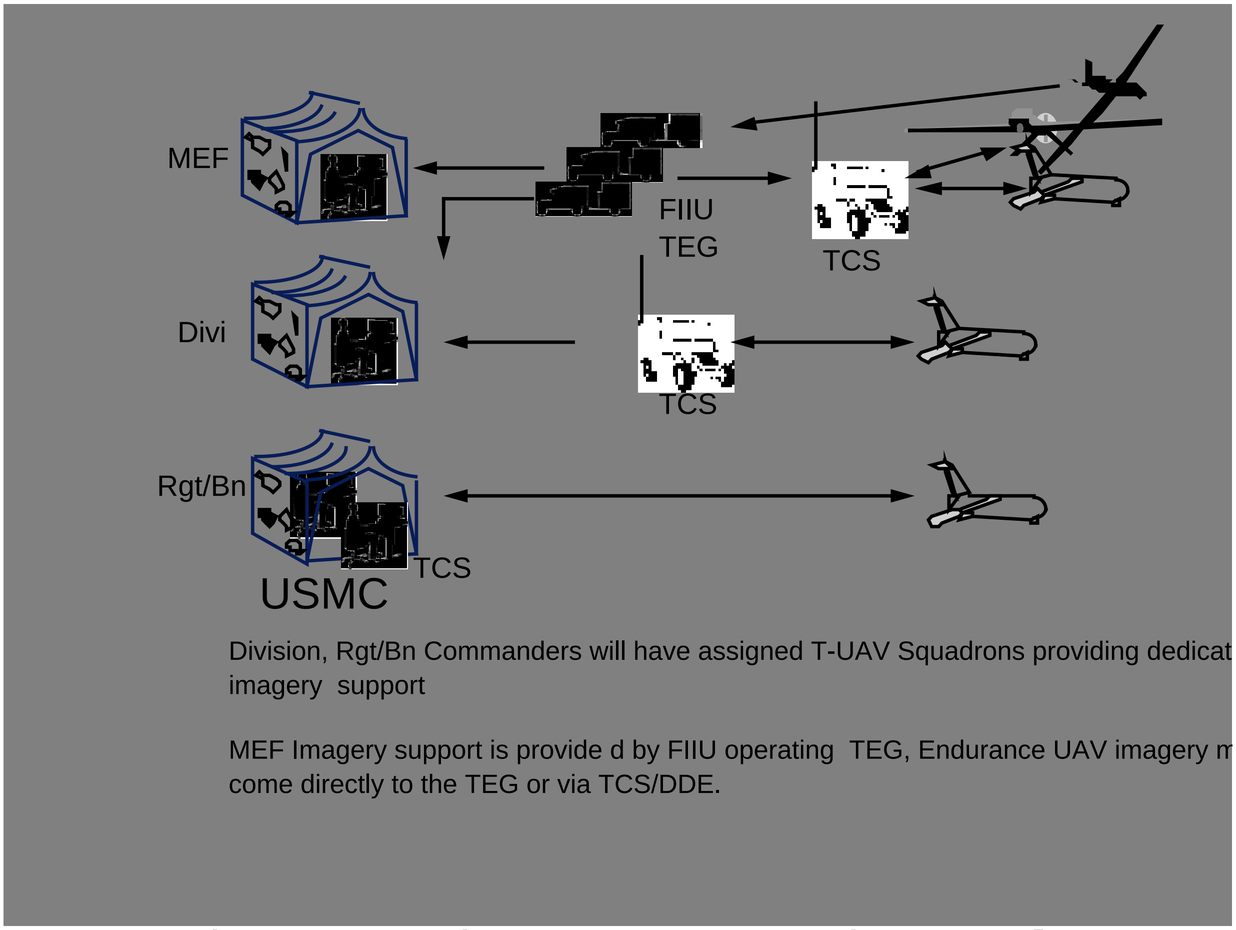

Figure 8-6 Marine Corps UAV Command & Control

8.5.4 Air Force

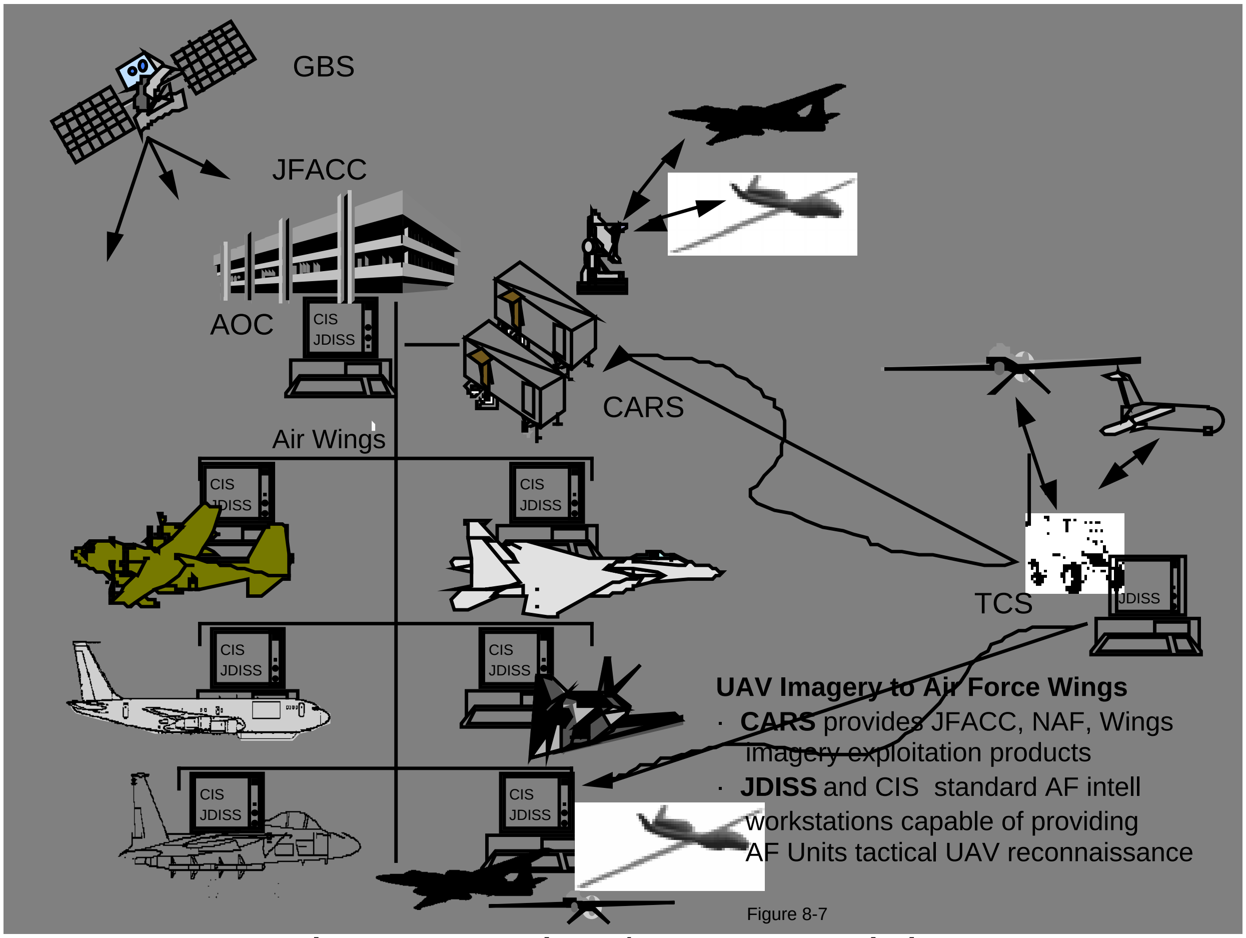

Figure 8-7 Wing / UAV Connectivity

The Air Force will operate Global Hawk, Dark Star and Predator UAVs. These UAVs may be assigned as Theater Joint or JFACC assets. In either case, Air Force has the structures in place to fully access Endurance UAV imagery. Figure 8-7 is an attempt to show Air Force access to UAV imagery. CARS, the Air Force Imagery exploitation center, has the capability of supporting the Theater, JFACC, Air Wings and other collateral commands. CARS products are frequently imagery-derived intelligence reports. JDISS gives CARS a secondary imagery dissemination capability. The Air Force Combat Intelligence System provides all source intelligence reporting and analytical products. JDISS is being deployed to Air Operations Centers and Air Wings. The JDISS network provides the ability to disseminate imagery products throughout the Air Force Command structure.

In a similar manner, Air Force will control Predator via TCS. TCS will also be equipped with JDISS for imagery dissemination. In addition, Air Force units would be able to access to Outrider imagery. A TCS controlling Outrider can support AOC and Air Wing requirements.

Global Broadcast System provides an additional means to supply Air Force Units with UAV and Endurance UAV imagery. All units in the GBS footprint and equipped with a GBS receiver may be granted access to disseminated imagery.

Section Nine
Communication Architecture

9.1 General

TCS supports direct connectivity to standard DoD tactical (VHF, UHF, VHF/UHF, and HF) radios, Mobile Subscriber Equipment (MSE), and military and commercial satellite communications.

Figure 9-1, below, contains some useful definitions. These definitions were developed by the Defense Airborne Reconnaissance Office (DARO) to support a quicklook UAV Ground Control System Commonality study. Of particular interest to this section of the TCS CONOPS are Interoperablity and Integration definitions. JCS Pub 1-02 defines Interoperability as:

> **Interoperability - (DoD, NATO)** The ability of systems, units, or forces to provide services to and accept services from other systems, units, or forces and to use the services so exchanged to enable them to operate effectively together.

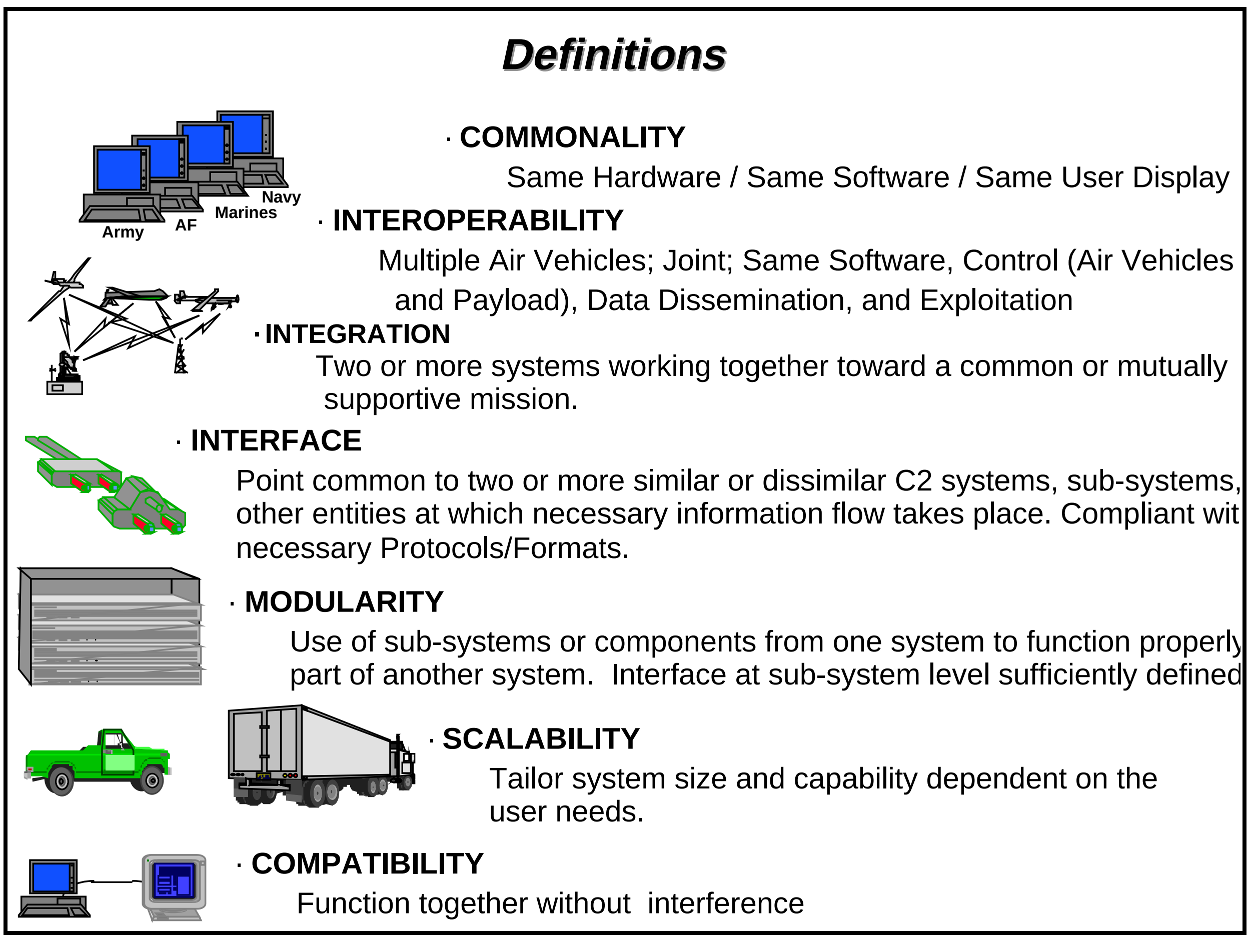

Figure 9-1 DARO Definitions

Integration is the first level of commonality between two systems or two components. To achieve integration two systems must be able to pass, receive and act on transferred data. Interoperability is a more complex concept. Interoperability implies an ability of two or more independent systems operating as components of the same system. The JCS and DARO definitions of Interoperability convey the concept of multiple reconnaissance platforms being interoperable with multiple ground elements. The DARO Architectural objective is to achieve interoperability between DARP collection platforms and either Joint or Service command and control and/or exploitation systems. Interoperability is not a new idea. Each Service has or is building ground stations to receive and control sensor data from the Air Force's U-2 Reconnaissance platform. The Joint Services Imagery Processing System (JSIPS) program was designed to provide ground station interoperability with either National Input Segment (NIS) or Tactical Input Segment (TIS) reconnaissance collectors.

The central tenet of TCS is to provide interoperability between the tactical and endurance UAVs and C4I structures which supports the tactical echelons of command of all US Services. TCS may also provide some level of interoperability with NATO forces. (See paragraph 9.3.3 below)

9.2 Integration

Points of Integration In April 1996, the DARO quicklook study, "UAV Ground Control System Commonality", identified five points in the reconnaissance architecture where integration may occur. The five points of integration are: data links, ground stations, data processors, archives, dissemination and command and control. As a point of integration, command and control may be unique to unmanned vehicles.

9.2.1 Data Links

There are three types of data links to consider: SATCOM; point to point line-of sight (LOS) and; broadcast or ommi-directional.

Several data links have been developed to satisfy specific needs. To achieve either integration or interoperability the data link transmitter and receiving elements must be compatible. The Common Imagery Ground/Surface System (CIGSS) specifies standards for ground stations within the DARO architecture. CIGSS calls for two "standard" data links, The Common Data Link (CDL) and the national SATCOM data link, Direct Dissemination System (DDS).

CDL is a family of line-of-sight data links that has been in use in the U-2 program for several years. CDL is used by CARS and ETRAC. TEG for the Marines will also use CDL. CHBDL, used by the Navy, is a part of the CDL family. All of these systems operate up to 274 MBits/S and are line-of-sight, point-to-point high speed data transfer systems. A Tactical Interoperable Ground Data Link (TIGDL) at 10.71 MBits/S is in development. TCS will be TIGDL capable.

The tactical UAVs (Predator, Hunter, Pioneer and the Outrider), use a UHF data link. The UHF data link meets the tactical UAV 6MBits/S requirement at an affordable cost, weight, and power budget. TCS will be UHF-Data Link capable.

Under NATO Project 35, (See paragraph 9.3.3 below) the United Kingdom is developing a NATO standard broadcast data link. TCS will be NATO Broadcast-Data Link capable.

To break away from LOS restriction, the endurance UAVs (PREDATOR, Global Hawk and Dark Star) will use a KU-Band commercial SATCOM as an alternate data link. CIGSS has not specified a standard for commercial SATCOM. TCS will be KU-Band-Data Link capable.

9.2.2 Common Ground Stations

The objective of the TCS program is to develop common ground station software that can be operated in a stand alone configuration or as additional functionality in an existing command and control or exploitation station. In a stand alone configuration TCS will have basic imagery screening and exploitation capabilities. However, the preferred mode of operations is to pass collected imagery directly to the operational and/or intelligence user.

9.2.2.1 UAV Command and Control

Mission Planners The Services are migrating toward a common mission planner. The Air Force and Army use the Air Force Mission Support Systems (AFMSS). The Navy and Marines use Tactical Air Mission Planning Systems (TAMPS). Both of these systems plan the flight track of the air vehicle. Both systems are capable of being adapted to reconnaissance sensor planning. TCS will be capable of operating with either AFMSS for the Army and Air Force or TAMPS for the Navy and Marines.

Flight Control The HAE UAVs, Global Hawk, Dark STAR, and the TUAV (Outrider) will use highly automated flight control systems. These systems follow a predetermined flight plan. To comply with dynamic sensor retasking and safety-of-flight, turn points can be altered in near-real time. Pioneer, Hunter, and Predator use remotely piloted systems. Initial TCS capability will include flight control for Outrider and Predator. All future Tactical UAVs will be controlled by TCS. A decision to control Pioneer and Hunter remains to be determined. TCS will not have air vehicle control over Global Hawk or Dark Star.

Sensor Control Under all applications TCS will have full, pre-planned and real time, control over imagery sensors on PREDATOR and all Tactical UAVs. TCS will have the ability to receive selected imagery directly from the HAE-UAV system. (See the discussion on DDE paragraph 9.3.1 below). Through the use of the DDE software, TCS may have virtual or actual control of HAE-UAV imagery sensors. When an HAE is tasked by the Joint Force Commander serving Joint requirements and/or supporting multiple tactical commands, actual control of the HAE imagery sensors is expected to be retained in HAE Mission Control Element (MCE). Virtual control (responsive compliance to tactical commander's dynamic request) may be extended through the HAE-MCE. The HAE-UAV sorties or portions of sorties may be dedicated to a tactical commander. Through the use of the DDE and TCS software tactical echelons may execute full control over HAE imagery sensors.

9.2.2.2 Exploitation

The primary function of TCS is command and control of tactical UAVs and the sensor data dissemination to operational command and control elements or intelligence exploitation systems. TCS will have imagery screening capability. The screening capability will include selecting video clips for storage and dissemination and the recognition of battlefield activities.

TCS controlled Predator and Outrider data may be passed to a data archive, a CIGSS intelligence exploitation facility or directly to an operational command and control element. TCS will also have the ability to receive HAE-UAV imagery and route that imagery to a tactical archives, exploitation or operational units. TCS will become the common source of UAV data to the lower echelons of command.

Tactical intelligence exploitation support is accomplished in a Service CIGSS element, CARS for Air Force, ETRAC/MIES or TES for Army, JSIPS-N/DIWS(A) for Navy and TEG for Marines. TCS will route imagery to CIGSS elements in the CIGSS prescribed NITFS 2.0 format. TCS may be collocated with or as an application loaded on CIGSS workstations. When TCS is not collocated with CIGSS, sensor data will be disseminated via Global Broadcast System, Trojan Spirit II or standard theater communications networks.

A central tenet of the TCS concept of operations is compliance with the DARO architecture and the Services' intelligence support doctrine. Compliance with both DARO and Service guidance is essential to achieving interoperablity with Service command structures and DARO developed ISR infrastructure.

9.2.3 Processors Formats

Development of the Common Imagery Processor (CIP) is under contract to Northrop Grumman. CIP is designed to process SAR and EO/IR imagery. CIP products will be in the national imagery transmission standard format NITFS 2.0. Use of the CIP processor will enable TCS products to be CIGSS compliant. The TCS Program Office will determine the practicality of employing CIP.

9.2.4 Archives/Storage Media

As discussed in Section 8, the National Imagery and Mapping Agency (NIMA) is developing a family of Imagery Product Libraries (IPL). IPL may be sized to meet local requirements. The use of a local IPL or a storage device compatible with IPL standards will greatly enhance TCS ability to contribute to integration and interoperablity of reconnaissance systems. Use of IPL standards will allow the HAE-UAV and other tactical reconnaissance assets to deposit selected images in the TCS archive for extraction by tactical command and control or intelligence support systems to include Joint STARS/ CGS, ASAS, TEG, IAS and others. Global Broadcast System, Trojan Spirit and the HAE-DDE will provide the capability to disseminate imagery and supporting data to TCS while deployed on a dynamic battlefield.

9.2.5 Dissemination Architectures

The final and arguably, the most critical point of integration, are the Services' dissemination architectures. TCS is committed to be compliant with each Service and Joint C4I for the Warrior Communication network. These networks are discussed in paragraphs 8.5 and 9.4.

9.3 Interoperability

9.3.1 Interoperable with HAE-UAV

The DARPA Program Manager for HAE-UAV and the TCS Program Manager have agreed to install HAE Direct Dissemination Element (DDE) software in the TCS to facilitate the dissemination of HAE imagery to tactical echelons of command. This capability will satisfy the TCS ORD requirement to receive/disseminate data from the High Altitude UAVs. DDE functionality will provide a capability for tactical echelons to receive and display, store and retrieve HAE UAV images, dynamically task HAE-UAV sensors, monitor platform and collection status, and participate in video teleconferencing with up to five other locations sharing the same images.

Figure 9-2 illustrates DDE functionality and objectives. The figure also provides in bullet format the descriptive detail of DDE functionality.

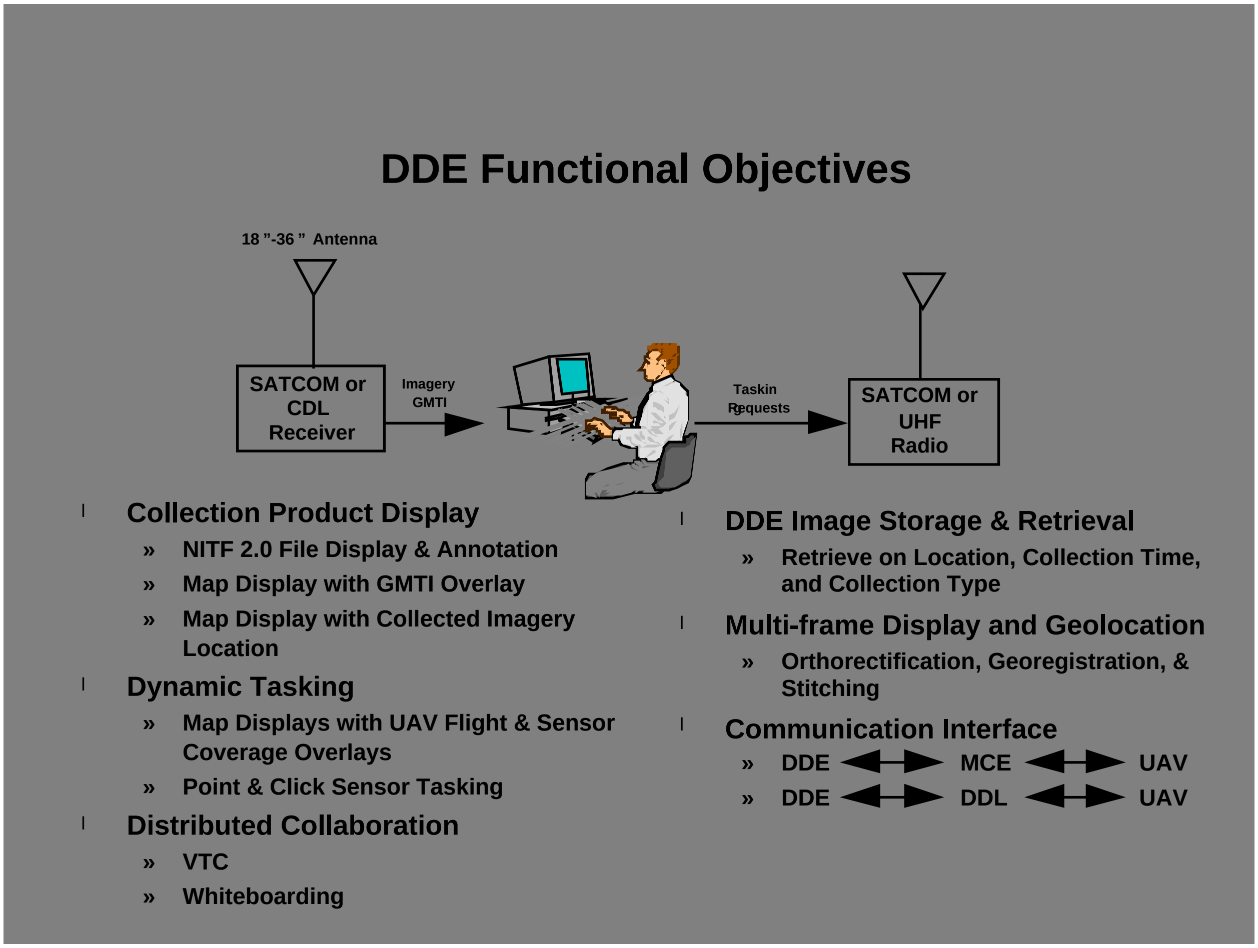

Figure 9-2 DDE Functionality

9.3.1.1 HAE Basic Concept of Operations

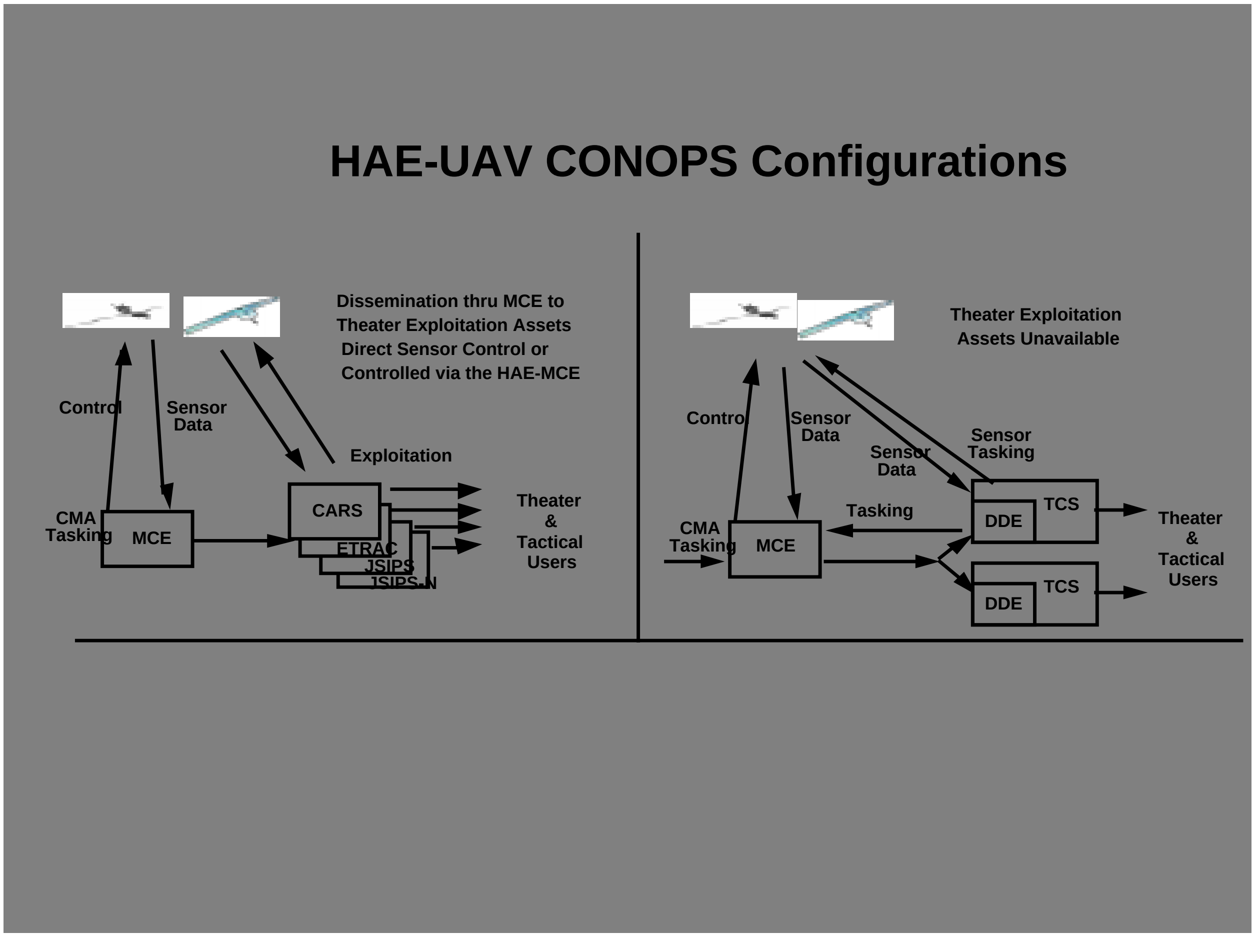

Figure 9-3 HAE UAV Configurations: Basic & plus DDE

Figure 9.3 illustrates the HAE CONOPS. The left side of the graphic illustrates the basic HAE ACTD CONOPS. HAE UAV will provide imagery products in NITFS 2.0 format directly to CIGSS elements (CARS, ETRAC, JSIPS-N and TEG) via CDL when within line-of-sight or either directly via SATCOM or indirectly through the HAE-MCE when beyond line-of-sight. DDE, as illustrated on the right side of figure 9-3, will enable the TCS to receive, request, store and disseminate HAE Imagery. A demonstration of DDE capabilities can be arranged through the HAE Program Office and will be demonstrated as part of the 1997-98 HAE ACTD.

9.3.1.2 DDE Description and Functionality

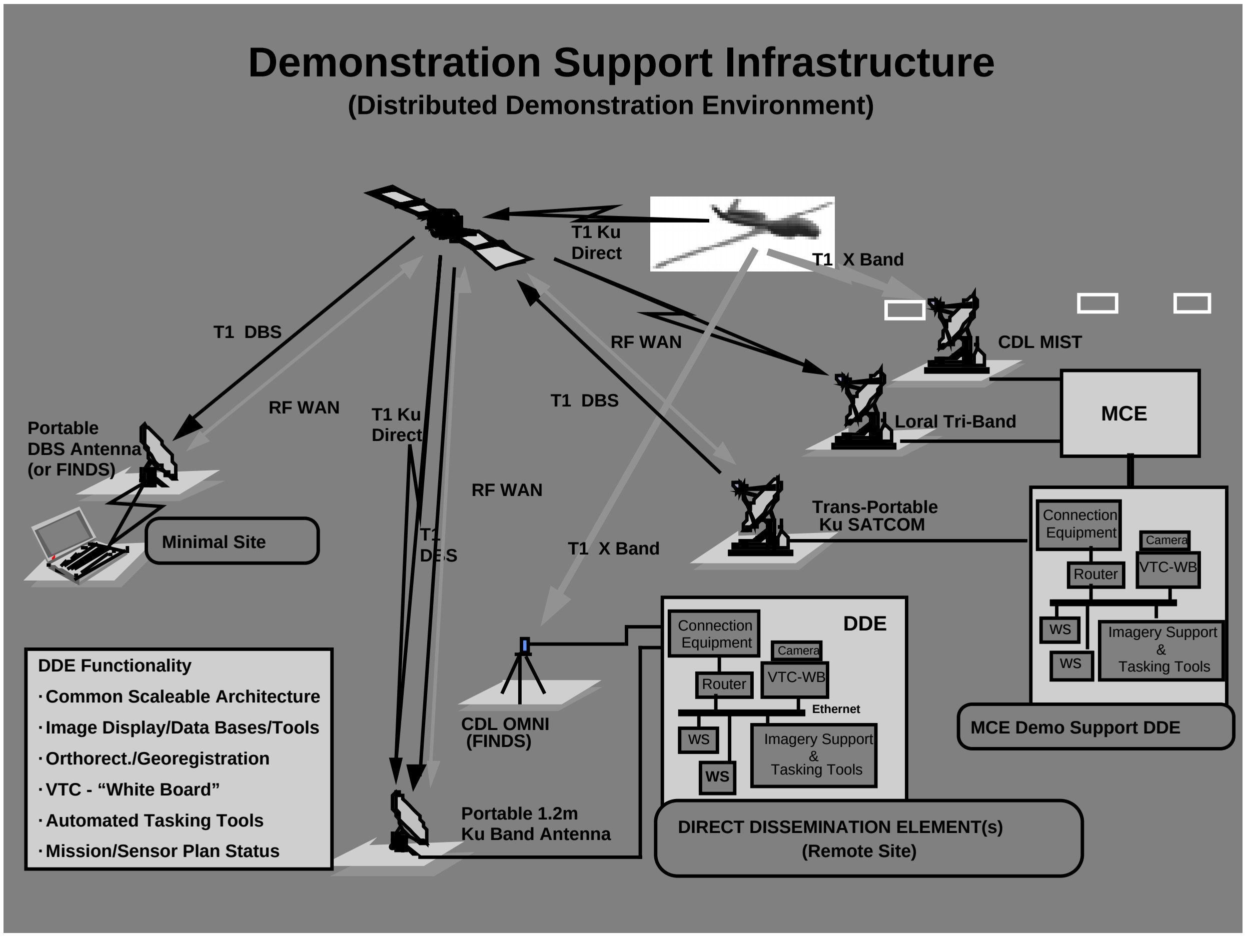

Figure 9-4 Demonstration Support Infrastructure

Figure 9-4 illustrates DDE connectivity. Illustrated are three possible data links between the HAE-UAV and the HAE-MCE. These are all current capabilities. CDL is currently used in the U-2 program and is the CIGSS standard line-of-sight data link. The Tri-band data link (MOBSTR) is in use today relaying U-2 imagery of Bosnia to CARS at Beale AFB, CA for exploitation. The imagery products are disseminated in near-real time via Global Broadcast System to US and NATO forces in Europe. KU-Band Commercial SATCOM are currently supporting the Predator program in Bosnia and will be available to provide HAE and Predator connectivity via a commercial network. A capability is being developed to provide direct connectivity from the HAE UAV to TCS equipped with DDE. Again four methods of dissemination have been engineered: (1) Directly from the UAV using TIGDL at a T-1 rate; (2) directly from the HAE via KU-Band satellite; (3) indirectly through the HAE-MCE via Ku-Band; and/or (4) Global Broadcast System.

Also illustrated in figure 9-4 is the RF Wide Area Network used for dynamic retasking and video teleconferencing. Video

Teleconferencing is a bonus capability provide by SATCOM links. This capability will allow up to five commanders to view, confer, and modify the collection in real time all having access to the same images.

9.3.2 Interoperability with Joint STARS Common Ground Station (CGS)

An Army objective is to provide UAV imagery to Joint STARS CGS. There are several ways in which this objective may be accomplished. TCS may be a stand alone system or application software on users workstations. As a stand alone system TCS may be collocated with a CGS or operated from a remote location.

TCS and CGS on the same work station: CGS could assume TCS functionality; the advantages would be a single set of hardware mounted on one or two HMMWVs. A major design feature of TCS is to be capable of operating on the hardware being procured by all four Services. There are some disadvantages. CGS is typically operated by two Army Specialists. A concern was raised by Army ACS/I that these Specialists should not be overloaded with additional responsibilities. They serve a critical Army mission. Joint STARS aircraft to CGS is via the SCDL data link. SCDL does not have the capacity to support UAV Video imagery. An additional data link will be required.

TCS collocated with CGS: Connectivity between collocated TCS and CGS may/be accomplished in three ways. TCS and CGS may both operate within the footprint of the Outrider data link. This footprint is approximately a 20 KM ellipse varying with UAV altitude. The footprint of the TIGDL in development has not been determined. Both TCS and CGS will need the same data link receiver elements. TCS will be equipped with an IPL image archive. By placing all TCS processed or received (HAE) imagery in the IPL, the CGS software could draw the most recent imagery from any source. This would allow for a single methodology for Joint STARS/UAV synchronized or independent operations. Finally, when collocated, TCS CGS connectivity may be via a direct fiber optic or hardwire feed.

TCS supporting CGS from a remote location: TCS and CGS may participate in coordinated missions without being collocated. UAV imagery may be made available to a wide range of users via Direct Broadcast System (or Global Broadcast System), Trojan Spirit, JDISS or similar secondary imagery transmission systems. UAV reports may be available via ASAS, IAS, JMCIS or CIS, the Services’ all source intelligence handling systems or via product reporting from the Services’ tactical exploitation systems (CIGSS).

9.3.3 Interoperable with NATO

The Joint Tactical UAV Program Office has participated in NATO reconnaissance interoperability discussions. The purpose of these discussions is early identification and development of interface standards. When developed these standards will be adopted as NATO STANAGS. Data links are viewed as the critical interoperability issue. Three standard data links are being discussed. The United States CDL to include TIGDL is being considered as a line-of-sight, point-to-point data link operating in the I or X Band. No data link has yet been prescribed for the UHF band; however, the Hunter data link is a possible choice. The British have committed to developing a omni-directional broadcast data link. No standards have been discussed for satellite data links.

A three-phase demonstration is planned for 2001. Phase I in 1998 will involve a US-provided TCS and a German-provided SEAMOS UAV and ground control station. The demonstration is planned for a German test range. In phase II the TCS mounted on a land vehicle will control both the US-provided UAV (Pioneer, Outrider or Predator) and the German SEAMOS. In the final demonstration (2001), TCS on-board US, British and German Naval Vessels will control both US and German UAVs.

9.4 Service Considerations

9.4.1 Army

9.4.2 Navy

9.4.3 Marines

9.4.4 Air Force

Section Ten
Security

10.1 General

10.2 Classification Guidance

10.3 Operations Security

10.4 Communications Security

10.5 Physical Security

10.6 Service Considerations

10.6.1 Army

10.6.2 Navy

10.6.3 Marines

10.6.4 Air Force